The Glasgow Naturalist

Journal of the Glasgow Natural History Society

Volume 27 Part 1

With Supplement : On the Wildside Revisited: 200 Years of Wildlife in the Glasgow Botanic Gardens

Glasgow Natural History Society

(formerly The Andersonian Naturalists of Glasgow)
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The Glasgow Naturalist

The Glasgow Naturalist is published by the Glasgow Natural History Society ISSN 0373-241X. It was first issued in 1909 and is a peer-reviewed journal that publishes original studies in botany, zoology and geology, with a particular focus on studies from the West of Scotland. Full details of the journal can be found at www.gnhs.org.uk/gnat.html

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Advice to contributors is given on the back inside cover of this edition and at www.gnhs.org.uk/documents/gn_information.pdf For questions or advice about submissions please contact the Editor Dr Iain Wilkie (E-mail: Editor@gnhs.org.uk) Craigeniver, Strachur, Argyll PA27 8BX.

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Front cover Green hairstreak (*Callophrys rubi*) – Low Moss, East Dunbartonshire, Scotland, May 2017.
(Photo: C.J. McInerny)
Back cover Machair – near Balnakeil, Durness, Sutherland, Scotland, July 2017. (Photo: L. Allen)

The Glasgow Naturalist
Volume 27 Part 1

Edited by: Iain C. Wilkie & Christopher J. McInerny

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EDITORIAL

A new editor's 35 year perspective

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Following on from the publication of the Supplementary issue devoted to *The Amphibians and Reptiles of Scotland* conference, this is the first normal issue of Volume 27 of *The Glasgow Naturalist* (*TGN*) and the first appearing since I took over from Dominic McCafferty as Editor. Dominic had that responsibility from 2008 until 2017 and oversaw the publication of Volumes 25 and 26, which comprise a total of 11 issues, including one supplementary issue. He left the journal in rude health and it is therefore a daunting task to ensure that standards do not slip.

Fortunately I am not a complete novice regarding *TGN* editorial duties. I became a member of Glasgow Natural History Society (GNHS) in 1983. Although at that time the late Eric Curtis was Editor of *TGN*, shortly thereafter Ron Dobson took over this role. I have in my possession a letter dated 28th February 1984, which was written by Ron to a colleague of mine at Glasgow College of Technology (now Glasgow Caledonian University), who was also a GNHS member, inviting him join the *TGN* editorial committee as "zoological sub-editor". My colleague felt he could not take on the commitment and asked me if I was interested. I was indeed interested and thereby embarked upon a fascinating editorial adventure. The editorial committee at that time consisted of Ron Dobson, Jim Dickson, the late Allan Stirling and myself. Meetings were held in the University of Glasgow Botany Department (Bower Building) and were minuted. Each meeting started with the Editor reading through the (hand-written) minutes of the previous meeting. The sub-editors then introduced and gave their views on those submitted manuscripts they had been asked to evaluate by the Editor, and final decisions on the fate of submissions were endorsed by the whole committee. Little, if any, advice was sought from specialists outwith the editorial committee. All this is a far cry from today's procedures where members of the editorial committee communicate almost exclusively by e-mail and rarely meet as a group face-to-face, all contributions are peer-reviewed by external experts, and final decisions, whilst informed by reviewers' reports, are made largely by the Editor alone.

There have been other changes. In the letter mentioned above, Ron Dobson also noted that "Our authors tend to be rather inexperienced and we may have to do a lot of rewriting to make papers acceptable." Neither of these points applies any longer. The majority of the articles in this and recent issues are by, or at least include amongst the authors, experienced professional biologists, and rarely is much rewriting required of submitted papers that get through the reviewing process. There are likely to be various reasons for these particular differences, which may, of course, be causally connected. Since it is now the case that submissions to *TGN* are rarely rejected, professionals have not been elbowing out amateurs in a bloody struggle for limited publication space, and therefore there have been two independent changes: (1) a decrease in the submission rate of articles from amateurs and (2) an increase in the submission rate from professionals. Change 1 is perhaps surprising in view of the growth of the Citizen Science movement (see Downie & Forster, 2019), and the popularity of natural history programmes on the TV, but it fits with the suggestion that "specialist amateurs are on the decline while more generalist volunteers and environmental enthusiasts are on the rise" (Lawrence, 2010; cited by Everett & Geoghegan, 2016). It also begs the questions: "How can we convert enthusiasts into specialists?" and "Is GNHS doing enough in this regard?" Change 2 may reflect increased appreciation by professional biologists of *TGN* "product quality", which (we hope) is approaching that of professionally managed biological journals, and of features such as online availability of articles both on the GNHS and Biodiversity Heritage Library websites (especially since they are online on the GNHS website prior to print publication) and printing in full colour (McCafferty, 2018); and/or it may be a sign of increasing scepticism about the use of journal impact factors and other metrics to assess and manage academic research (Wilsdon *et al.*, 2015), which is making professional biologists more "relaxed" about publishing in bibliometrically invisible journals; a survey of *TGN* authors' attitudes would be needed to test this hypothesis! Change 2 is desirable and requires the Editorial Committee to remain vigilant in maintaining standards. Change 1 needs to be reversed, so that *TGN* does not come to be perceived as off limits to amateur contributors. One way to encourage submissions from amateur naturalists might be to provide help with drafting articles: aspiring authors (only those with no previous publications in *TGN* would be eligible) would submit an article outline together with

relevant observations/data and literature references; if thought to have enough scientific value, the Editorial Committee would then use this material to assemble a full paper or short note, which would, like all other submissions, be subjected to external review. Another possibility would be to pair up amateurs with professionals. I would welcome views on these ideas.

This issue is notable in including the first six articles of a series that we are calling *On the Wildside Revisited: 200 Years of Wildlife in the Glasgow Botanic Gardens*. A similar series headlined *On the Wildside: the Natural History of the Glasgow Botanic Gardens* appeared 20 years ago in *TGN* 23(3,4). An informative introduction to the new series is provided by Downie & Forster (2019). The other contributions in this issue eneompass a healthy diversity of taxa and geographical locations. Taxa range from fungi through vascular plants to a range of insects, the vertebrate-like invertebrate amphioxus, and an example of Creation's crowning glory - the naturalist-photographer. Locations, whilst dominated by Glasgow (not unexpectedly, in view of the new series), include Loch Lomond's shores (no produet placement intended), the seas around Scotland from the Firth of Clyde to Shetland, and most of the continents of the wider world (for the purpose of making international comparisons of evolution education): *TGN* can certainly not be accused of being parochial. Some minor changes have been introduced into Volume 27: the journal title and other details are now printed on the spine cover; the names of external reviewers are now listed (see below); and some aspects of formatting have been standardised, such as only the initials of authors' first and middle names being included below the title of each paper, and common names of all organisms being printed without initial capitals. If readers have any further suggestions for improving the appearance and organisation of the journal, please communicate them to me or another member of the Editorial Committee.

ACKNOWLEDGEMENTS

Editing *TGN* is very much a team effort and I would like to acknowledge the assistance of Chris McInerny, Ruth Maclachlan and Richard Weddle, and the advice of Dominic MeCafferty. The evaluation of submitted manuscripts by external experts is critical for maintaining the journal's scientific standards and all who made such a contribution to this issue are thanked wholeheartedly. The external reviewers for this issue were (in alphabetical order): K. Anderson, S.J. Chambers, D. Clements, M. Culshaw, A. David, J.R. Downie, S. Eaton, B. Etheridge, C. Fox, S.J. Gregory, G. Hancock, X. Lambin, E. Moorkens, L. Pereira-da-Conceicoa, S. Roberts, J. Robinson, R. Sutcliffe, A. Taylor, G. Walker, A. Wardlaw, K. Watson and I.J. Winfield.

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FULL PAPERS

Evolution education in Scotland, and around the world

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INTRODUCTION

Evolutionary geneticist Theodosius Dobzhansky (1973) wrote that "nothing in biology makes sense except in the light of evolution". Although there were important antecedents, what we now think of as the "theory of evolution" started public life at a meeting of the Linnean Society in London in 1858, where papers by Charles Darwin and Alfred Russell Wallace were read proposing the process of natural selection as the means by which organisms could change over time. This was followed in 1859 by the publication of Darwin's book *On the Origin of Species* (Darwin, 1859). Thereafter, Darwin published several other books and revised editions of the *Origin* further articulating and expanding his ideas on the process that became known as "evolution". Let us not forget Wallace, who made later important contributions to our understanding of biogeography and is commemorated by Wallace's Line marking a discontinuity in animal distributions in the Far East. Since the early work, thousands of scientific papers and many books have been written more fully documenting, articulating and testing Darwin and Wallace's essential ideas; several scientific journals are devoted to the topic, like *Evolution* and the *Journal of Evolutionary Biology*.

The theory of evolution encompasses a number of basic propositions concerning the history of life on Earth:

- The Earth is very ancient (billions of years old) and so is the origin of life on Earth.
- Species of organisms are related by descent with modification.
- Organisms change over generations, mostly slowly; the changes are mostly adaptive, fixed in populations by the process of natural selection.
- Although most of the heritable variations on which natural selection works are generated randomly, the close relationship between environmental conditions and natural selection means that evolutionary change is anything but random.
- Evolution is an inescapable part of life, continually leading to alterations in the characteristics of living organisms: there is no final perfect state, and no state which organisms strive to attain.
- Human beings are related by descent to other animal species.

Different biologists might add to or slightly alter this set of propositions, but it will suffice for the purposes of this contribution. Among biological scientists, this set of propositions is uncontroversial and agreed. Despite this, the general public is not so sure, particularly in some countries. Mostly, the public do not feel competent to challenge scientific ideas and evidence, but a few cases are exceptional, the most obvious being evolution, anthropogenic climate change, and sometimes the causes of and how to cure disease. Evolution is generally challenged for religious reasons: it contradicts the particular creation story embedded in a particular religion's founding texts or traditions. The fact that each major religion tends to have its own, different creation story makes these challenges especially odd, and the leaders of many religions have come to terms with the idea that their creation stories are just that, stories whieh perhaps provide some guidance, but not factual accounts of what happened. The problem mainly arises where particular religions insist on the literal truth of their texts, i.e. the religions we label "fundamentalist".

MY INTEREST IN EVOLUTION ACCEPTANCE AND REJECTION

I became interested in evolution aeceptance and rejection, and what they imply for educational strategies, when teaching evolution in the foundation Biology course at Glasgow University in the 1980s. I was aware of the high levels of evolution denial in the U.S.A., and wondered whether this was simply an American issue, as many thought at the time, or whether it was more widespread. We surveyed Glasgow biology students over nine sessions (and medical students over one), 1987-1999, and published the results in 2000 (Downie & Barron, 2000). This was apparently the first such survey of U.K. students.

The basic question we asked was: "Do you accept that some kind of biological evolution, lasting many millions of years, has occurred on Earth?" Over the years, 3.9 to 11.3% of biology students (and 10.2% of medical students in one year) rejected evolution. You might regard this rejection level as low, but recall that these are biology or medical students, and remember

Dobzhanky's statement on the centrality of evolution to biology.

Jumping to autumn 2016, an invitation came out of the blue from two U.S.A.-based science educators, Hasan Deniz and Lisa Borgerding, to contribute a chapter to a book to be titled *Evolution Education around the Globe*. The invitation resulted from the 2000 paper and a few others since then. I accepted on condition I could bring on board some helpers: Paul Braterman who is knowledgeable on the incursions of ereationists into schools; Ronan Southcott, a biology teacher whose masters research on evolution acceptance I supervised; Naomi Barron, my wife, who helps with data analysis. The research and writing were intense because the editors were working to a tight deadline. After chapter submission, all principal authors took part in the review process, with each reviewing two other chapters and responding to the comments on their own chapter. All this plus some attempts at standardisation took time. The book was eventually published as an e-book by Springer International in July 2018 (Deniz & Borgerding, 2018). The main aim of this article is to give a snapshot of the findings, including ours from Scotland.

THE BOOK

Overall contents and strategy

In addition to introductory and eoncluding chapters by the editors, *Evolution Education around the Globe* (Deniz & Borgerding, 2018) has 22 chapters on different parts of the world (Table 1).

As the editors acknowledge, the coverage is patchy, with some important gaps: no Russia (evolution was enthusiastically embraced under communism, although in a distorted form, but what has happened since?), no China (except Hong Kong, rather a special case), only one African country (except for some coverage of north African Arab states). But the book is 464 pages long.

Authors were asked to address six themes:

- Public acceptanee of evolutionary theory within the social and cultural context of their country or region.
- Whether there are anti-evolution movements in the country or region.
- The plaee of evolutionary theory in the curriculum.
- The emphasis given to evolutionary theory in the curriculum.
- Biology teachers' attitudes towards evolutionary theory.
- Suggestions to improve evolution education in the country or region.

The focus of most chapters is on evolution education at school level, but some also go into tertiary education coverage. To help make comparisons, each chapter contains some account of the structure of the education system in the country and how curricula are decided. All authors were given an approximate word limit, but chapters range in length from 13 pages (England's) to 28 pages. Ours at 26 pages is one of the longest.

Overall conclusions

Table 2 summarises the school level at which evolution is first taught.

Region	Chapters
North America	Four on different states in the U.S.A
Central and South America	Mexieo, Brazil, the Galapagos Islands (Ecuador)
Europe	England, Scotland, Greece, France, German-speaking countries
Middle East	Turkey, Iran, Arab states
Asia	Hong Kong, Indonesia, Malaysia (two chapters), Philippines
Africa	South Africa
Oeeania	New Zealand

Table 1. Coverage by region and countries in the book *Evolution Education around the Globe* (Deniz & Borgerding, 2018).

School Level	Countries
Primary, before age 10	England, France, NZ, Philippines, U.S.A. (some states)
Middle, age 10-13	Austria, Germany, Greece, Iran, Kuwait, Luxembourg, Mexico, Scotland, South Africa, Switzerland, U.S.A. (some states)
High school, above 14	Brazil, Egypt, Greece, Hong Kong, Indonesia, Malaysia[1], Syria, Tunisia, U.S.A. (some states)
Not required/omitted	Lebanon, Malaysia[1], Turkey (after 2017)
Banned	Algeria, Morocco, Oman, Saudi Arabia

Table 2. School levels at which evolution first appears in the curriculum in different countries. [1]Malaysia appears twice because there are two chapters, with strikingly different accounts of the situation. One states that evolution is taught in the senior school biology curriculum; the other that evolution has been deleted as part of an overall Islamification of the education system.

Some countries appear more than once, partly because of internal variation, especially in the U.S.A. where individual states have a lot of autonomy. Actual banning of evolution is found only in a few predominantly Muslim countries, but it should not be deduced from this that there is agreement in Islamic countries that evolution is against their religion; note, for example, the early introduction of evolution into Kuwaiti and Iranian schools. I do not here attempt to cover the whole book, but rather pick out some themes.

Part of the book's context is an international survey of the general public by Miller *et al.* (2006) of the levels of acceptance of evolution in 34 countries, using the level of agreement with the statement: "Human beings, as we know them, developed from earlier species of animals" as the criterion. The findings were that in most European countries and Japan acceptance was 75% or higher, in the U.S.A. it was only 40%, and in Turkey, it was a low 25%.

ISLAM AND EVOLUTION

Turkey

Turkey was the only predominantly Muslim country in the sample collected by Miller *et al.* (2006). It is notable that the survey statement does not use the name "Darwin", or the word "evolution", but does focus on human origins, unlike the statement we used for Glasgow biology students, which used the term "biological evolution" and referred to its long time scale, but did not mention humans. It is very probable that differences in survey questions make a major impact on the responses.

Of the majority Muslim countries, the book covers Turkey (officially 100% Muslim), Iran (98% Muslim), Indonesia (87% Muslim), Malaysia (61% Muslim) and a set of Arab states (89-100% Muslim). Attitudes to evolution and its teaching in these countries are deeply influenced by religion, politics and history.

For example, in Turkey, after the fall of the Ottoman Empire at the end of World War 1, the new leader, Kemal Ataturk initiated a transformation of society. The Ottoman Turkish literacy level was only 10%. Ataturk brought in a secular education system, including the teaching of evolution in elementary and secondary schools, in the 1930s. This was not welcomed by religious conservatives, and Darwin and evolution were excluded soon after Ataturk's death in 1938. Turkey remains a political battleground between those who welcomed Ataturk's secularisation of the state and those who wish to re-embed Islam as a governing system (Mugaloglu, 2018).

In 2006, Harun Yahya, a Turkish Islamist with American creationist backing, published and widely distributed (free) volume 1 of *Atlas of Creation* which argued that the fossil record shows no evidence of evolutionary changes (Yahya, 2006), with volumes 2-4 published up to 2012. It is hard to know what influence the book has had. Evolution was re-instated into the curriculum after the 1940s but a series of Turkish curriculum reforms in 1999, 2005, 2013 and finally 2017 have ended with the removal of "evolution" and "Darwin" as terms for use in schools. According to the head of the curriculum board "students are too young to understand controversial subjects".

Arab states

In the Arab states, school coverage of evolution goes from bad to worse. Evolution is included in the curriculum of four Arab states: Egypt, Syria, Tunisia and Kuwait, but causes conflict. In Egypt, teachers are reported to instruct students to study evolution, since it is required for examinations, but not to believe it, since it conflicts with religion. In Jordan, evolution is taught in very general terms, along with relevant Qur'an verses. Evolution is banned from schools in Saudi Arabia, Oman, Algeria and Morocco. In Saudi, evolution is mentioned in a grade 12 biology text as an erroneous and blasphemous theory which contradicts the teachings of Islam. Strangely, this situation changes in some Saudi universities where courses on evolution are available and academics pursue research on evolutionary themes, often in collaboration with researchers abroad. As the chapter writer notes, the research is published in English in international journals, far from the sight of the religious police (BouJaoude, 2018).

Iran

Iran is an Islamic Republic, with religion as the basis of the government. However, as in most things, Iran follows almost the opposite course to Saudi Arabia in the context of evolution. Like Turkey, Iran underwent huge societal change in the 1920s, with a western-style educational system introduced, modelled on that of France. Science and technology were seen as the future for the country, and several new science-based universities, such as that at Shiraz, were founded. The Islamic revolution of 1979 led to a temporary closure of the universities, and many curriculum changes. Perhaps surprisingly, this did not lead to a rejection of evolution, which had been introduced to the school biology curriculum prior to the revolution (Kazempour & Amirshokoohi, 2018).

In Iran, the standard nation-wide curriculum introduces evolution in the final year of primary school, with coverage of Earth history, emergence and evolution of living organisms, the colonisation of land, dinosaurs and extinctions. Junior secondary includes a more detailed treatment with natural selection and mutations. The upper secondary biology text has a 40 page chapter on evolution, including the statement: "nearly all biologists to-day have accepted that Darwin's theory can explain the basis for the diversity of life on earth." The only stumbling block is human evolution. Iranian education accepts natural selection within the human population, but not the origin of humans from other animals. This means that Iran would be classed as rejecting evolution on the basis of the question used in the survey by Miller *et al.* (2006), but not in ours (Downie & Barron, 2000).

CRUCIBLES OF EVOLUTION-1: GALAPAGOS, INDONESIA AND GREECE

The theory of evolution has close associations with a number of places: I was interested to find how well this showed up in the associated book chapters.

Galapagos

The Galapagos chapter (Cotner & Moore, 2018; Moore is an eminent evolution education researcher and was for many years editor of the journal *American Biology Teacher*) is exemplary. They note that the few hundreds of people resident on the islands when Darwin visited have swollen to 25,000 residents, with serious consequent impacts on the environment, and augmented by 170,000 annual visitors. Tourism contributes 70% of the islands' earnings, and most of this is Darwin-based. There are Darwin street names, statues, merchandise and the Darwin Research Station with its visitor facilities.

Cotner & Moore (2018) put forward a hypothesis: that Galapagos residents would be better acquainted with evolutionary theory and more accepting of its conclusions than people elsewhere. A Pew Research Centre 2014 survey of religion in Latin America, including some Caribbean islands found levels of acceptance of human evolution ranging from a low of 41% in the Dominican Republic to a high of 74% in Uruguay, with Ecuador, of which the Galapagos are part, at only 50%.

Cotner & Moore (2018) surveyed 38 out of the 43 (88%) biology and natural seience school teachers working on the Galapagos, all of whom had college level education from mainland Ecuador. The rate of acceptance of evolution was high, 76% using the human evolution question, but knowledge of the details was often poor. All were aware of the *Origin*, but only 50% knew approximately the time of Darwin's visit to the islands (many chose 1535, rather than 1835!). Around 90% were proud of Darwin's connection with the islands and enjoyed teaching about evolution and the islands' role, but 80% felt uncomfortable teaching about evolution, and perceived a conflict with religion.

Indonesia

I had hoped to find some similar recognition in Indonesia, where Wallace, unwell on the island of Ternate, wrote the paper on natural selection that stimulated Darwin to break his decades of silence at the Linnean Society in 1858; and where he established the key discontinuity in animal distribution later known as Wallace's line. Sadly, the Indonesia chapter (Rachmatullah *et al.*, 2018) has nothing on Wallace. However, it does recount the country's efforts to modernise its science education. Following a terrible ranking (61st out of 69) in an international assessment of science literacy, Indonesia introduced a new science curriculum in 2013. Evolution is included in the secondary school biology curriculum, but "alternatives" such as the views of Harun Yahya, and intelligent design are discussed. The chapter reports a study of pre-service biology teachers who displayed a poor understanding of evolution concepts. As is common throughout the book, evolution acceptance among these trainee teachers was strongest for micro-evolution (within species), intermediate for macro-evolution (the origin of new species) and weakest for human evolution. Indonesia is the most populous majority Muslim country in the world, and, like Iran, shows that religion is not necessarily in conflict with science.

Greece

The scientific study of animals began in Greece, with several books by Aristotle (384-322 B.C.), such as *Enquiries into Animals* (Leroi, 2014). Although Aristotle was not an advocate of evolutionary change, he was the first person we know of to make serious studies of living organisms, what they do and how they are constructed, and his findings were not significantly improved on for many centuries. The chapter on Greece (Kampourakis & Stasinakis, 2018) notes that Darwin's "*Origin*" was not translated into Greek until 1915 (contrast with Germany where the first full translation appeared in 1860, within a year of first publication). However, there has been no serious religious objection to evolution in Greece. Deficiencies in evolution education there derive from poor preparation of teachers and a highly constrained educational structure. In correspondence, the authors regret the omission of Aristotle from the curriculum, and the absence of a consideration of the nature of science and its history in general.

CRUCIBLES OF EVOLUTION-2: FRANCE, ENGLAND AND SCOTLAND

France

French science played a key role in the emergence of evolutionary ideas (Quessada & Clement, 2018). One of Darwin's antecedents was Lamarck whose promotion of evolutionary change was strenuously opposed by his Natural History Museum of Paris eolleague Cuvier in the early 19th century (Stott, 2012). French state schools were secularised in the late 19th century, and evolution became part of the national school curriculum from that time. French scienee clung on to Lamarck's version of evolution well into the 20th century (the idea of change being based on individual striving, rather than on selection on population variability pools, and of evolution being directed towards particular ends rather than being directionless, which was especially promoted by the priest-paleontologist Teilhard de Chardin). Now, however, a more Darwinian view is fully accepted. In schools, Yahya's notorious *Atlas of Creation* (2016) was widely distributed in 2008, but the Ministry of National Education took rapid action: schools were forbidden from putting it in their libraries. (I remember being asked by the Principal of the University of Glasgow what he should do with the copy he had been sent. My view was that students' understanding of the evidence for evolution should be robust enough to see through Yahya's claims, so I had no objection to the book being shelved in the University of Glasgow Library; but schools are probably a different case). Overall, France comes fourth highest for evolution aeceptance in survey by Miller *et al.* (2006). Evolution education begins in

primary school and deepens through the secondary years.

England

Darwin spent most of his life in England, largely in Kent, with one year as a medical student in Edinburgh, then, more famously, his voyage on *The Beagle*, 1831-36. Wallace also spent most of his life, when not on collecting trips abroad, in England. The Linnean Society meeting announcing their idea of natural selection as a process for evolutionary change was in London. So England is central to the theory of evolution. It is also important to the development of biology education, with Thomas Henry Huxley promoting science education in universities through his work on several Royal Commissions. Oddly, Huxley's influential biology courses (e.g. Huxley and Martin, 1875) were heavily weighted to comparative anatomy, rather than to the study of living animals, or to the evidence for evolution, despite his public role as "Darwin's bulldog" (Ruse, 1997).

The book's England chapter is by Michael Reiss (2018), an interesting choice of author. Reiss is professor of Science Education at University College London's Institute of Education, as well as being an ordained Church of England priest. He was for a time director of education at the Royal Society of London, but resigned in 2008 following a controversy that developed from his speech to that year's British Association for the Advancement of Science meeting in Liverpool. His speech alluded to pupils who have creationist views, and he contended that science teachers risk alienating such pupils by simply dismissing creationism out of hand. He said that teachers "should take the time to explain how science works and why creationism has no scientific basis". Some felt that Reiss's resignation was more damaging to the Royal Society than to Reiss himself. Interestingly, Reiss does not mention this episode in his chapter, although he does write extensively on anti-evolution opinion in England. In my view, he rather exaggerates this, writing "evolution is now seen in England as a site of contestation within the curriculum", while at the same time quoting the Department of Children, Schools and Families 2007 guidance on the topic:

"Creationism and intelligent design are not part of the science National Curriculum…and should not be taught as science. However, there is a real difference between teaching 'x' and teaching about 'x'. Any questions about creationism and intelligent design which arise in science lessons, for example as a result of media coverage, could provide the opportunity to explain and explore why they are not considered to be scientific theories and, in the right context, why evolution is considered to be a scientific theory."

Reiss notes that the science curriculum in English primary schools now includes evolution, but is hampered by the "small proportion of primary teachers who have learnt biology since they were 16 years old". This is a common worry from many chapters throughout the book.

Much of Reiss's chapter is about dealing with pupils who enter science classes with an anti-scientific, usually fundamentalist religious, worldview, and how hard it is to change such minds. I agree that it is hard, but an issue he does not tackle is why society feels it legitimate for young people to have their minds so brain-washed in the first place.

Scotland

I last discussed the public response in Scotland to the theory of evolution in a *The Glasgow Naturalist* editorial (Downie, 2001a) and briefly in an article on Glasgow Natural History Society's history (Downie, 2001b). The Society traces its origin back to 1851, just seven years before Darwin and Wallace's papers were read to the Linnean Society. Did the new ideas impact on the Society? The archives show that Professor John Scouler, honorary president of the Society, and who had visited the Galapagos a decade before Darwin (Nelson, 2014), addressed the Society twice, in 1862 and 1863 (publishing his views in a paper: Scouler, 1863) on the transmutation and permanence of species. He was critical of the idea of natural selection and did not think that Darwin had put forward anything substantially new. Later, John Young, Professor of Natural History at the University of Glasgow, was also somewhat sceptical in two talks to the Society in 1868 and 1892.

How then can I claim Scotland as a "crucible of evolution"? There are several reasons: first, Darwin's interests in natural history were greatly encouraged during his year as a reluctant medical student in Edinburgh, by getting to know Robert Grant, then researching the nature of sponges, who persuaded Darwin to join the local natural history society. He did so, and published his first paper through the society, aged 18. Second, Robert Chambers, radical Scottish writer, published (anonymously) *The Vestiges of the Natural History of Creation* (1844), asserting that the Earth is very ancient and that species are changeable, deriving his ideas from Darwin's grandfather Erasmus, among other influences. Although the book was condemned by the churches and by most academics, it was very widely read and helped create a climate susceptible to new ideas. Third, Scottish geological discoveries were influential. Hugh Miller was a devout Christian, but also an excellent geologist: it was clear to him that the Earth must be much older than the Bible suggests. Another Scot, James Croll, estimated the Earth's age as around 500 million years, much nearer to what Darwin's theory required than the estimate made by Lord Kelvin. Despite the cool reception in Glasgow, the basic idea of evolution was quickly accepted in Edinburgh, which hosted the 1871 British Association for the Advancement of Science meeting, including several talks on evolutionary themes.

I now turn to evolution education in Scotland. In early 20th century Scottish schools, science was mainly physics and chemistry. Prior to the publication of a new biology syllabus in 1968, fewer than 1000 pupils a year took national Scottish examinations in all the branches of biology. This has changed dramatically. By 2010,

biology was the third most popular subject studied in Scottish schools. In 2011, Standard Grade Biology presented over 20,000 candidates. We are now in the era of the Currieulum for Excellence: how well does it deal with evolution?

In the general science curricuium, the theme *Planet Earth* introduces biodiversity and the inter-dependence of living organisms at level 4 (secondary year 3), a first hint of evolution. At year 4, the National 5 Biology syllabus has a chapter on evolution including natural selection. So far so good, although introduced later than in France and England, and not all pupils take National 5 Biology. After that, there is a problem: pupils choose between Higher courses (examined in year 5) in Biology or Human Biology, with those hoping to study medicine often preferring Human Biology. Higher Biology has several chapters on evolution, taking the subject to a deeper level. Human Biology has none, not even any eoverage of human evolution, a very disappointing situation.

In the book, our chapter (Downie *et al.*, 2018) reports on evolution edueation in sehools and in tertiary education, and analyses the attitudes to evolution of Scottish biology teachers. As in other countries, school teachers are expected to teach evolution after remarkably little learning of the subject themselves (many had no more than a University first year level of evolution content in their pre-teacher training degrees). The majority of our sample of 149 Scottish biology teachers felt that evolution is adequately covered in the curricula, except for Higher Human Biology; 83% agreed that the theory of evolution is a valid scientific explanation for the occurrence and diversity of organisms past and present. It is a worry that 15% did not agree.

Our chapter discusses the prevalenee of anti-evolution influences in Scottish schools. In addition to learning about the origin of biodiversity in the science curriculum, pupils are exposed to Religious and Moral Education, a core primary and early secondary school theme. At senior school levels, this becomes an optional course in Religious, Moral and Philosophical studies. The course textbook for Higher level (Walker, 2016) is sound on the science of the origins of the Universe and life on Earth. However, at primary school level, the influence of the head teacher can be considerable, for example in the choice of visiting school chaplains. It is not uncommon for children to learn about the Roman invasion of Britain and Noah's Ark as if they had equal status as history. A representative of a U.S.A.-based fundamentalist church acted as chaplain to a school near Glasgow for some years, and the first parents knew of his activities was when children brought home a book stating that evolution is an unscientific lie used to promote immorality. It is a continuing anomaly of Scottish education that, by law, each Local Authority education committee includes three unelected church appointees, one Protestant, one Catholic, and one other.

We also report on our work on evolution acceptance and rejection by students at the University of Glasgow, taking further our earlier work (Downie & Barron, 2000). We were pleased to find that there is a slow downwards trend in evolution rejeetion among Glasgow biology students, and that first year evolution rejectors have often changed their minds by final year. Unfortunately, it appears that the ehange results from realising that their religion is more accepting of evolution than they had thought, rather than a serious consideration of the evidence. Our data show that amongst the main religions our students adhere to, evolution rejection is significantly higher among Muslim than among Christian students. When we ask students why they reject evolution, the reason given overwhelmingly is that they prefer to accept a religious creation account. We find it alarming that young people, starting on a career in science, can think in this way: that a set of beliefs absorbed in their youth can over-rule scientific evidenee.

CONCLUSIONS

Here is a statement from the InterAcademy Panel on International Issues, representing the academies of science of countries around the world and aecepted by 67 countries, including Egypt and Moroeco: "We, the undersigned Academies of Science, have learned that in various parts of the World, within scienee courses taught in certain public systems of education, scientific evidence, data and testable theories about the origins and evolution of life on Earth are being concealed, denied, or confused with theories not testable by scienee. We urge decision makers, teachers, and parents to educate all children about the methods and diseoveries of science, and to foster an understanding of the science of nature" (InterAcademy Partnership, 2006).

The book's chapters on Malaysia demonstrate the problem. Lay *et al.* (2018) describe how perceived confliet with religious beliefs has limited the coverage of evolution in Malaysian schools, but that there is fair treatment of the subject in form 6 Biology. However, the account from Osman *et al.* (2018) is more up to date, and reports the deletion of evolution from the country's sehool curriculum. They describe the increasingly strong influence of "Islamic values": "The acceptance of an 'Islamic' approach to seience is based upon the notion that the scientific methods are not the sole way to knowledge acquisition, but plaees equal importance on the other way of knowing such as intuition and revelation...More importantly, the insertion of Islamic and moral values in teaching science is to make students realise that seience is not only a way of gaining new knowledge but also a means of appreciating and realising the presence and greatness of the Creator."

The idea that intuition and revelation are of equal value to scientific procedures in acquiring knowledge about the natural world will be profoundly damaging to the development of science of any kind in Malaysia and any other countries where this notion has taken hold.

There are many challenges in the teaching of any aspeet of science, including evolution: at what curricular stage to start; to what depth to go, and how gradually; does

everyone need to know the subject in depth, or only students proceeding to a particular specialism? However, it is profoundly dispiriting in the 21st century, over 150 years beyond Darwin and Wallace's original proposals, to find whole countries denying the science of evolution, not on the basis of any evidence, but on the basis of inculcated religious beliefs.

ACKNOWLEDGEMENTS
This paper is an expanded version of the (past) Presidential Address given to Glasgow Natural History Society on 18th September 2018. I thank Hasan Deniz and Lisa Borgerding for the invitation to contribute an article on evolution education in Scotland, which led to the talk; also my colleagues Paul Braterman, Ronan Southcott and Naomi Barron who contributed to the article. Chris Finlay kindly gave permission for a new survey of Glasgow Biology-1 students in 2016.

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The Glasgow Naturalist (2019) Volume 27, Part 1, 10-19

Water vole (*Arvicola amphibius*) abundance in grassland habitats of Glasgow

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ABSTRACT

Water vole (*Arvicola amphibius*) populations have undergone a serious decline throughout the U.K., and yet a stronghold of these small mammals is found in the greater Easterhouse area of Glasgow. The water voles in this location are mostly fossorial, living a largely subterranean existence in grasslands, rather than the more typical semi-aquatic lifestyle in riparian habitats. In this study, we carried out capture-mark-recapture surveys on water voles at two sites: Cranhill Park and Tillycairn Drive. We made a total of 62 captures including retraps, and the resulting population estimates were 78 individuals (95% confidence interval 41-197) for Cranhill Park and 42 individuals (20-141) for Tillycairn Drive. From these figures we estimated a population density of water voles, which appeared to be higher than other reports from the U.K. Despite the difficulties of sampling in urban environments that resulted in relatively low capture rates, our data suggest that the greater Easterhouse area of Glasgow holds water voles at relatively high population densities. These results will inform future conservation in the City of Glasgow and surrounding areas, as well as raise awareness of important water vole populations in urban environments.

INTRODUCTION

Water voles have suffered severe declines in the U.K. due to habitat fragmentation, industrialisation, intensification of agricultural practices and predation from American mink (*Neovison vison*) (Strachan, 2004). Consequently, water voles are protected in the U.K. under the Wildlife and Countryside Act 1981 (Strachan, 2004). Approximately 40% of the U.K. water vole population is thought to reside in Scotland with the majority of water vole colonies found as upland metapopulations (i.e. discrete colonies maintained by frequent immigration and emigration events from nearby colonies), which are spread across the Cairngorm mountain range and Assynt (Stewart *et al.,* 1998; Capreolus Wildlife Consultancy, 2005). In the U.K. the distribution of water voles is almost exclusively associated with riparian habitats.

Riparian water vole populations consist of multiple breeding units strung-out along the length of the water course with females being the territorial sex during the breeding season, demarcating the area with piles of droppings (latrines) and actively excluding other females, in contrast to the larger home range of the males (Strachan & Moorhouse, 2006). The length of habitat occupied is dependent on population density with mean territory size measuring 30-150 m for females and 60-300 m for male home ranges at high and low densities, respectively (Strachan & Moorhouse, 2006). The mating season is triggered by increasing day length in early spring and extends from March through to September (Strachan & Moorhouse, 2006), although breeding as early as February has been documented (Stoddart, 1970). On average, females give birth to five to eight offspring and have multiple litters throughout the breeding season. Life expectancy can reach three years but a lifespan of twelve months is more common. Water vole populations are subject to high over-winter mortality rates averaging 64% (Carter & Bright, 2003), but reaching as high as 70% of animals (Strachan & Moorhouse, 2006).

For some time there has been confusion over the exact habitat preference of water voles, particularly because suitable sites will often go unoccupied (Lawton & Woodroffe, 1991). It is widely accepted, however, that established colonies require a length of continuous riparian habitat, slow-flowing water, soft banks for burrowing, and dense vegetation for both cover and food (Lawton & Woodroffe, 1991; Aars *et al.*, 2001; Telfer *et al.,* 2001; Lambin *et al.,* 2004; Fischer *et al.*, 2009). Habitats subject to heavy grazing, trampling or over-shading by trees are actively avoided (Strachan & Moorhouse, 2006). The length of riparian habitat required varies between lowland and upland populations, largely because of habitat quality, with lowland colonies occupying lengths of 100-400 m (Lawton & Woodroffe, 1991) and upland colonies occupying lengths 50-700 m, although length varies between years (Capreolus Wildlife Consultancy, 2005).

However, elsewhere in Europe water voles are also found in dry grassland habitats and are regarded as fossorial. Water voles found in dry grassland favour upland meadows and can be found at high population densities in mountain regions (Berthier *et al.,* 2014).

Distribution is not limited by water features and burrow systems can exceed 100 m in length in a complex array of runs, nest chambers, food stores and bolt holes and will usually house a single breeding unit, a male and female, with their offspring (Meylan, 1977). Their existence is almost exclusively subterranean, foraging for rhizomes, tubers and fleshy roots along the runs (Meylan, 1977). Plugging up entrance holes with soil is a well-documented behaviour (Meylan, 1977), as is the ereation of above ground soil mounds, termed tumuli, a by-product of digging activity (Giraudoux *et al.*, 1995).

Fossorial populations can beeome a serious pest in some areas due to the economie impact they can have on agricultural crops and orchards by damaging root systems, consuming plants and digging extensive burrow systems which can destabilize soil structure (Meylan, 1977). Giraudoux *et al.* (1995) noted that in peak years populations were forced to expand into surrounding habitats even if they were unfavourable. Regulation of the population is thought to be largely down to density-dependent factors such as food availability and disease (Saucy, 1994).

It was initially thought that only riparian water voles occurred in Britain (Corbet & Harris, 1991). Historically dry grassland populations have been reported for only a few locations in the U.K., on island locations in Scotland and Reads Island in the Humber Estuary (Strachan & Moorhouse, 2006). Telfer *et al.* (2003) also identified large populations of fossorial water voles on a number of small islands in the Sound of Jura. In 2008 water voles were reported to occur in dry grassland habitats in the greater Easterhouse area of Glasgow, oceupying a variety of sites including public parks, gardens, vacant and derelict land and road verges (Fig. 1; Stewart *et al.*, 2017). The unusual characteristic of the water vole population here, aside from its fossorial habitat, is the high degree of urbanisation in the surrounding area. The importance of urban areas for water voles is beginning to be considered in the literature; for instance Brzeziński *et al.* (2018) document the use of urban areas as refuges for water voles, as their main predator American mink appear to avoid built-up habitats.

Fig. 1. Fossorial water vole (*Arvicola amphibius*), Cranhill Park, Glasgow, April 2017. (Photo: L. Campbell)

The fossorial water vole populations of the greater Easterhouse area of Glasgow face the constant threat of expanding urbanisation. Areas which until now have been vacant and derelict land suitable for water voles are in many eases the chosen sites for urban development, such as social housing. These development projects, though of great benefit to the community, require mitigation strategies for the water vole populations and Glasgow City Council is currently developing a Water Vole Conservation Strategy in partnership with a range of organisations including Scottish Natural Heritage (SNH) and the Seven Lochs Wetland Park (Glasgow City Council, pers. comm.). Management options for conserving water voles in prospective development sites include planning design whieh retains populations *in situ*, displacing animals into areas of newly created adjacent habitat and within and between-site reloeation by trapping (Dean *et al.*, 2016). To successfully earry out these management options, it is necessary to have an estimation of the population size at each site.

Various techniques have been used previously in order to estimate the abundance of water vole populations, including surveying for field signs (Telfer *et al.*, 2001; Berthier *et al.*, 2014), and by eapture-mark-recapture (CMR) studies (Telfer *et al.*, 2003), although most population estimations have been undertaken in riparian habitats. Previous work in Glasgow included field sign surveys, but no significant relationship was found between the abundance of field signs and water vole density (Stewart *et al.*, 2017; see the Appendix for a guide to identifying field signs). Therefore, the aim of this study was to carry out a more detailed estimation of the abundance of water voles occupying dry grassland habitats in the greater Easterhouse area of Glasgow.

MATERIAL AND METHODS

Trapping

Trapping was conducted at two sites: Cranhill Park (55°51'48.53"N, 4°10'06.27"W) and Tillycairn Drive (55°52'28.48"N, 4°08'56.41"W) in July and August 2015 (Fig. 2). Each trapping session was conducted over a five-day period with traps installed on the first day and left unset for approximately 24 hours. Trapping was conducted twice at Cranhill Park (denoted as *Cranhill 1* and *Cranhill 2*) and onee at Tillycairn Drive, but, due to some traps being stolen and problems with access to sites, trapping hours varied between Cranhill (July: 728 total trap hours; August 600 trap hours) and Tillycairn (July to August: 960 trap hours). Two types of traps were used: Sherman Folding Traps (model XLK, H.B Sherman Traps Inc., https://www.shermantraps.com) and specially eonstrueted tube traps based on a simple design from a German trap (Rohrenfalle), used for trapping fossorial water voles and moles (D. Gow, pers. comm.). The tube traps were constructed from grey plastic plumbing pipe (length 30 em, diameter 8.5 cm) with one-way hinged doors at either end.

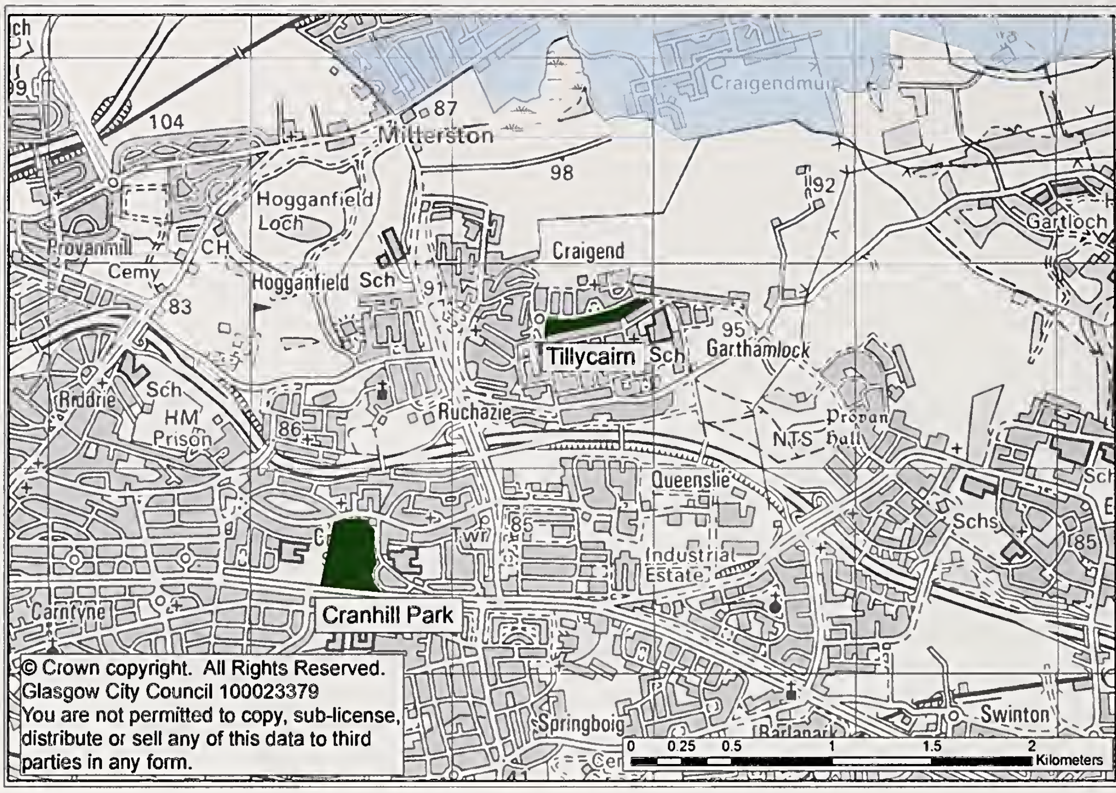

Fig. 2. Map showing location of water vole (*Arvicola amphibius*) trapping sites, Cranhill Park and Tillycairn Drive, in the greater Easterhouse area of Glasgow.

Paired traps were set at 10 m intervals along a 100 m transect following guidelines by Gurnell & Flowerdew (2006) and trap positioning based on Telfer *et al.* (2003). The paired traps at each trapping point were set at right angles to an obvious field sign (e.g. burrow entrance) at a distance of 50-100 cm depending on terrain. Traps were numbered prior to use and each trapping point was marked by a marker cane. Each trap was provisioned with around 120 g chopped carrots and fresh hay for bedding, with a handful of chopped apple placed at the entrance of the trap as bait (Strachan & Moorhouse, 2006). Traps were secured in position by placing them on flat ground in a water vole run or beneath a grass tussock. Once secured the traps were covered with vegetation to provide shelter, some degree of insulation and a visual barrier against predators and human interference. Traps were checked daily at 0500, 1300 and 2100, and were cleaned, re-provisioned and reset as necessary after each check. Once the five day trapping was complete, Sherman traps were autoclaved and Tube traps were disinfected.

Captured animals were transferred into a pop-up pen (Heavy Duty Polyethylene, height 58 cm, Gardman™, http://www.gardman.co.uk; Strachan & Moorhouse 2006). The water vole was then transferred into a cardboard tube and body mass ± 0.1 g recorded using a DIPSE PS-250 digital scale. Body length (nose to base of tail), tail length, hind foot length and anal-genital gap (to indicate sex) were recorded using a metal ruler (± 0.5 mm). Coat colour, presence/absence of ectoparasites (e.g. gamasid mites and fleas (Siphonaptera)) and general body condition were also noted. Animals were then marked by injecting an AVID™ Single-use Sterile Syringes PIT tag (www.avidplc.com) subcutaneously into the scruff between the shoulder blades. Following this, the animal was returned to the pen and monitored for five minutes and checked using the AVID™ Mini-Tracker Microchip Scanner to ensure marking was successful before release at point of capture under a grass tussock for cover. All trapping was carried out under Home Office Licence and with consultation from SNH.

Capture mark recapture (CMR)

Program MARK (www.phidot.org/software/mark/) was used to model water vole population size at each site based on CMR data. We assumed a closed population with no migration or birth/deaths (and therefore a constant number of animals) for each site. Closed population "Huggins p and c" model was chosen where N, the population estimate, is a derived parameter based on the number of animals detected and assumes an equal probability of capture for all individuals. This model was appropriate because of the short trapping time scale used during the breeding season with adults displaying strong site fidelity. The most parsimonious model was used in each case based on the model with the lowest corrected AIC against the highest AIC and lowest number of parameters (Stewart, 2015). The goodness of fit was tested using the variance inflation factor ($\hat{c}$) and 120 simulations run for each model. Due to the use of linear trapping methodology in a non-linear habitat only relative abundance estimates can be calculated for the areas sampled rather than true population density. However, the length and width of each trapping site

were measured using a 100 m measuring tape and the total area of each grassland patch calculated (ha) to provide an approximate density for comparison with previous studies. Areas were 0.5 ha and 0.15 ha for Cranhill Park and Tillycairn Drive, respectively.

Both trapping sites were classed as B2 (neutral grassland) according to a Phase 1 habitat survey (JNCC, 2010). All sites were urban and had sward composition resulting from varying degrees of management, for instance different frequency of grass cutting or varying fertilizer use. Cranhill Park had received the greatest amount of sward improvement compared with Tillycairn Drive due to grass cutting and the historical application of fertilisers associated with its previous use as a golf course. Sites were dominated by grass species and were low in plant species diversity. *Holcus* spp. were the dominant grass species at both sites with a mean percentage cover of 52% (SD = 10.6). Average sward height was 35 cm for Cranhill Park and 45 cm for Tillycairn Drive. Tillycairn Drive was classed according to the National Vegetation Classification (NVC; Rodwell, 1992) as MG1 *Arrhenatherum elatius-Festuca rubra* sub-community, a species poor community dominated by tall, tussock grasses. Sward composition could not be classified at Cranhill Park by the NVC system as species-poor grasslands dominated by *H. lanatus* and *H. mollis* do not fit into the current system (Averis, 2013).

Statistical tests were performed using the statistical programming environment R Version 3.3.3 (www.r-project.org).

RESULTS

Trapping

A total of 49 individual water voles were successfully trapped (45 adults and four juveniles; one adult male died on handling). Trapped individuals consisted of 31 females and 18 males, although this sex ratio difference was statistically non-significant (χ^2 = 3.45, df = 1, P = 0.063). The mean body mass of voles was 109.0 g (SE = 5.04, range = 38.4–221.7). Body length and body mass were positively related (ANCOVA $F_{1,46}$ = 67.12 P <0.0001; Fig. 3), but there was no difference in body mass between sexes after controlling for body length ($F_{1,46}$ = 0.26 P = 0.55). Linear regression (both sexes combined) was: mass (g) = 1.7 (SE = 0.21)*body length (mm) - 139.2 (SE = 29.93), ($F_{1,47}$ = 69.56 P <0.0001). There was variation in coat colour with 36, eight and five individuals with black, brown and intermediate coloured coats respectively (χ^2 = 35.80, df = 2, P <0.0001). Ectoparasites (mites and fleas) were found on 22 of the 49 individuals trapped. From a total of 62 captures (including retraps) Sherman traps were more successful, capturing 44 individuals compared to the 18 caught in tube traps (χ^2 = 10.90, df = 1, P = 0.001).

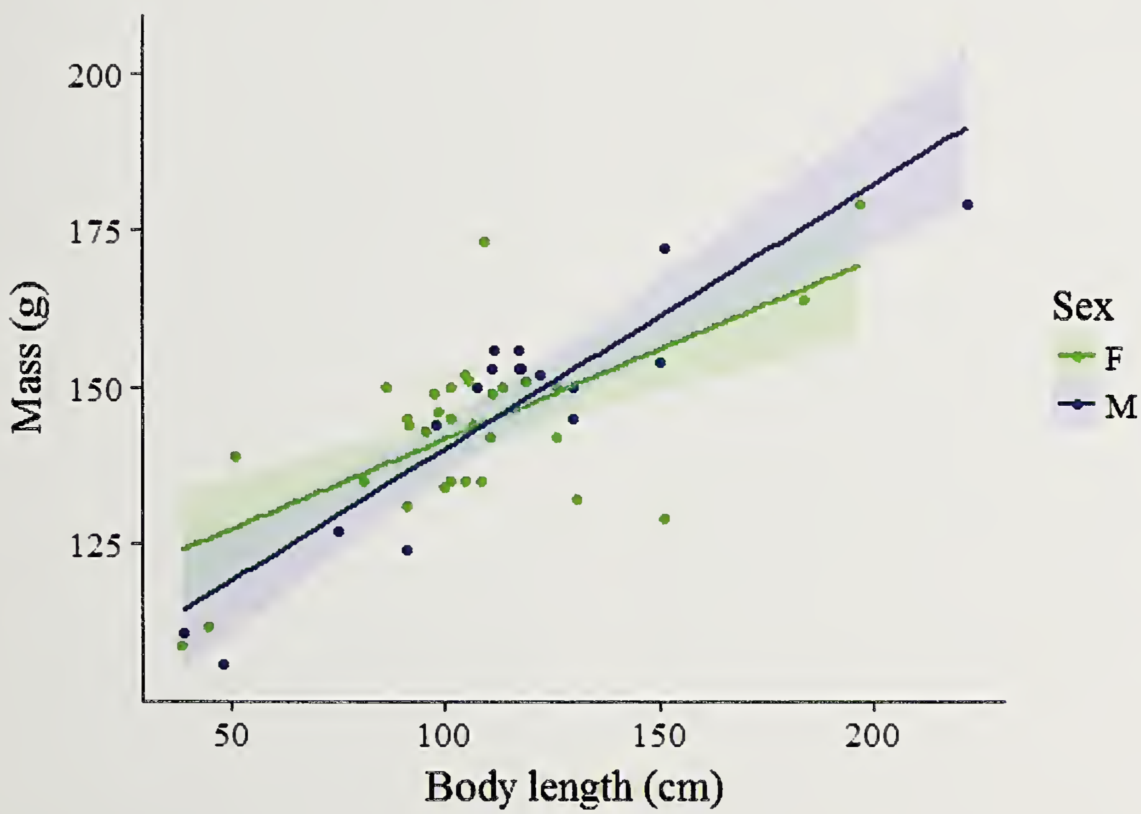

Fig. 3. Linear regression of mass (g) against body length (cm) of all water vole (*Arvicola amphibius*) captures. Females (F) are represented by green points and lines, with males (M) by blue points and lines. Shaded areas indicate 95% confidence limits.

Mark-recapture

From 48 water voles successfully marked with PIT tags there were 12 recaptures (adults: 11 female, one male). Only two animals were recaptured on multiple occasions: one female from Cranhill Park was recaptured twice and another female from Tillycairn Drive was re-trapped four times. For *Cranhill 1* and *Cranhill 2* the derived population estimates were 78 (95% Cl 41-197) and 42 (20-141) individuals, respectively. The Tillycairn Drive derived population estimate was six (5-10). This resulted in an estimated population density of 156 animals ha^{-1} (82-394), 84 (40-282) and 40 (33-67) for *Cranhill 1* (July), *Cranhill 2* (August) and Tillycairn Drive (July-August), respectively.

DISCUSSION

Recapture rates at Cranhill Park were low, 16% in July and 15% in August, meaning only a small percentage of the total population were marked; whereas recapture rates at Tillycairn Drive were 60% for adult water voles (juveniles were eonsidered non-resident within the habitat patch because of the likelihood of dispersal and excluded from analysis). Indeed, the especially low recapture rates at Cranhill Park appear to be site-specific. Aars *et al.* (2006) found recapture rates of 73 to 92% over a 4-day trapping period in upland Scottish populations. European fossorial water voles have in the past been found to be easily trapped with up to 70% of the population captured in the first day, but the methodology involved deliberately disturbing burrow entrances to elicit investigatory behaviour from the animal which increased ease of capture (Meylan, 1977). Telfer *et al.* (2003) found three days of trapping was adequate for the Sound of Jura fossorial voles but traps were set on fixed grids rather than the linear transect used in this study. The low rate of capture in Cranhill Park (and Tillycairn Drive to a lesser extent) resulted in less robust population estimates (Amstrup *et al.*, 2005) with associated large confidence intervals.

PIT tags are a proven effeetive method of individually marking animals and have a high retention rate (Harper & Batzli, 1996; Melis *et al.*, 2011), and therefore PIT tag failure or loss was eonsidered unlikely. Despite a trapping duration of five days being adequate for the majority of rodent populations (Gurnell & Flowerdew, 2006), future studies with water voles in Glasgow should consider a more extensive trapping period if trapping rate is low. However, extended trapping periods in urban environments will inherently carry more risk of disruption. Indeed this study was disrupted on multiple occasions: traps were interfered with, stolen, and dogs were witnessed attempting to dig out animals all of which are potentially wildlife crimes. These events, rarely encountered outside urban areas, could partially explain the low capture rate of the east Glasgow water voles.

In this study, estimated water vole abundance ranged from around 40 to 156 ha^{-1} across the two sites. Due to the limitations of working in public parkland, linear transects were used to give an approximate water vole abundance based on the area of habitat covered by the transect line. Additionally, the models created using the programme MARK assume a elosed population, whilst it is likely that there is connectivity between sites in the water vole populations of the greater Easterhouse area. Nevertheless, these estimates suggest relatively high abundance compared with other sites in U.K. Water vole abundance varies seasonally and across years and from previous studies in the U.K. densities of 40 to 50 animals ha^{-1} have been recorded in reed beds (Strachan & Moorhouse, 2006), while the fossorial populations of Scottish Islands had an average density of 26 ha^{-1}, inereasing to 70 ha^{-1} in Spring (Telfer *et al.*, 2003) which indicates that the water vole density found at Cranhill Park appears to be one of the highest recorded in the U.K. In continental Europe fossorial populations oscillate with a four to eight year cycle and in peak years water vole numbers can reach "outbreak" densities of 1,000 ha^{-1} (Meylan, 1977; Giraudoux *et al.*, 1995; Weber *et al.*, 2002; Berthier *et al.*, 2014). A mean population density of 476 ha^{-1} (range 80-900 ha^{-1}) has been reported for fossorial water voles in Jura Mountains of Switzerland (Weber & Aubrey, 1993).

Linear trapping along a transect line is a well-established sampling technique for many small mammal species (Gurnell & Flowerdew, 2006) and is the standard methodology for riparian populations of water voles (Strachan *et al.*, 2011). In this study, linear sampling was adopted because of cost constraints and concerns over sampling in the urban environment, and while it proved an effective method for initial research, sampling on a grid square pattern similar to that used by Telfer *et al.* (2003) would be recommended for any future work. Sampling on a grid pattern would also allow for the collection of information on individual spatial movements and provide insight into home range size. Whilst this study was only part of a pilot study and further work is required, our results do indicate that grassland water vole home ranges can be small at high population densities. The mean range size of water voles has been shown to decrease in response to higher quality foraging (Moorhouse & MacDonald, 2008), therefore it is possible that considerably smaller home range sizes can be supported in grasslands compared to riparian habitats.

Water voles trapped during this study had a mean body mass of 109 g, lower than previously recorded body size of 140-350 g in U.K. (Strachan *et al.*, 2011). However, given the small sample size and wide variation (range 38.4-221.7 g), and the likelihood that trapping included a number of sub-adults, we are reluctant to derive any conclusions on the body size of the east Glasgow water voles. Additionally, we captured a number of large males that reached a maximum body mass of 221.7 g. European fossorial water voles tend to be smaller in size but the range of 60-150 g quoted by Saucy (1994) could actually be for *A. scherman* rather than *A. amphibius* because it pre-dates Panteleyev's (2001) separation of the species based on morphological adaptations. The biometrics of fossorial east Glasgow water voles should be directly compared with those of neighbouring

riparian populations to investigate this fully. Juveniles were trapped only at Tillycairn, which is most likely due to the timing of trapping (28th July to 1st August) coinciding with the time of dispersal of the newly emerged juveniles (Strachan & Moorhouse, 2006).

This study is the first use of capture-mark-recapture in estimating population size of the fossorial water voles in the greater Easterhouse area of Glasgow. Our results suggest, despite low capture rates, that population densities of water voles are high, perhaps more comparable to continental European water vole populations than to riparian populations in the U.K. These findings underline the importance of management strategies to allow water vole populations to persist despite expanding urban areas. Indeed, Glasgow City Council is pioneering a proactive conservation strategy for water voles, creating a "green network" of sites across the greater Easterhouse area, with the hope of allowing water vole populations to persist, despite the loss of some of their habitat. Future research will necessarily involve further population surveys, in order to optimise management strategies for fossorial water voles of this area. We also hope that the provision of a guide to identifying field signs (see Appendix) will encourage other workers to study fossorial water voles at other locations.

ACKNOWLEDGEMENTS

We gratefully acknowledge support from D. Marshall (Land and Environment Services, Glasgow City Council), John Shelton and Shelagh MacMillan (Scottish Natural Heritage, SNH), S. Scott, S. Porch, Scottish Badgers Group, Cranhill Community Centre, Glasgow Countryside Rangers and Glasgow Community Safety Officers kindly assisted with fieldwork. Expertise was also provided by C. Balling (JDC Ecology), S. Babayan, P. Johnson, J. Laurie, P. McLaughlin (IBAHCM, University of Glasgow). Thanks also to M. Oliver, S. Telfer and E. Bryce (University of Aberdeen) for advice on trapping. Funding for the project was provided by Glasgow City Council, Scottish Natural Heritage and Glasgow Natural History Society. Trapping was conducted under Home Offiee Licence. This project was undertaken by R. Stewart in fulfilment of a Master of Research at the University of Glasgow.

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APPENDIX

Identification of fossorial grassland water vole (*Arvicola amphibius*) field signs.

Water vole field signs	Description/identification
   	**Burrow entrance (1-4)** • Diameter 4-8 cm. • Can be found on slopes or flat ground (1). • Burrow wider than high (2). Can be dug out by other animals so may occasionally appear much larger at entrance. • Well-defined opening when in use. • Tends to be in the open away from buildings, trees, etc. (water voles appear to favour garden decking and porta-cabins, however). • Water voles favour grassland with tussock-forming grass species. • Burrows can persist in the environment for years (water voles tend to be less active above ground during the winter months but may still be using the burrow). • Fan-shaped soil mound outside (occasional – tends to be when the burrow is freshly dug). • Clipped grass from feeding remains can be found around entrance (most common in springtime) (3). • Droppings around entrance, most common during the breeding season from April to September. • Water voles can abandon a burrow system but return to it the following season/year(s). • Water voles frequently block up burrow entrances using a mixture of soil, shredded grass and moss. This tends to be in response to disturbance or periods of heavy rainfall (4).

Soil mound (also known as tumulus) (5-6)

- Flattened soil mound created as a by-product of burrowing (diameter of each mound is variable) (5).
- Similar in appearance to a molehill but not as tall or conical-shaped.
- Often seen alongside a burrow entrance.
- Tend to be found in clusters rather than singular (6).
- Most frequently recorded during spring and autumn because they indicate periods of high activity associated with breeding then dispersal.

Feeding station (7-8)

- Water voles spend many hours foraging for plant material which they collect into piles (7).
- Collected plant material can be of varying lengths depending on the amount eaten but it will always be cut at a 45° angle.

- Piles tend to be situated at the base of a grass tussock or somewhere relatively covered (8).
- Water voles eat a broad range of vegetation including grasses, sedges, rush, bark, seeds and berries.

<table>
<tr>
<td></td>
<td>Droppings (9)

• The most definitive water vole field sign (9).
• 8-12 mm length.
• Circular in diameter with blunt ends.
• Green when fresh.
• Dark brown when dried out.
• Mostly odourless.
• Can be found at any time of year but most frequently seen in springtime and the breeding season.</td>
</tr>
<tr>
<td></td>
<td>Latrine (10)

• Piles of flattened droppings normally with fresh droppings on top (10).
• Highly seasonal – occurs only during the breeding season.
• Tend to be very conspicuous compared to feeding stations.
• Latrines are used for scent communication between males and females for the purpose of breeding. They also mark the boundary of a female’s territory.</td>
</tr>
</table>

The Glasgow Naturalist (2019) Volume 27, Part 1, 20-26

The honey-buzzard in Scotland: a rare, secretive and elusive summer visitor and breeder

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ABSTRACT
The honey-buzzard (*Pernis apivorus*) is probably Scotland's most enigmatic breeding bird of prey. The raptor is extremely difficult to observe, being rare, secretive and elusive. Over the past few years we have discovered two populations of honey-buzzards in central Scotland. Systematic and intensive monitoring of these populations has revealed new information about the species' annual breeding cycle. In this paper we review the history and distribution of the honey-buzzard in Scotland and summarise the results of our recent studies in central Scotland, which have considerably increased understanding of the species.

INTRODUCTION
The honey-buzzard is widespread in the Western Palearctic, breeding from Britain and continental Europe through to western Asia (del Hoyo *et al.*, 1994; Hagemeijer & Blair, 1997; Batten, 2001; Ferguson-Lees & Christie, 2001). The raptor is a trans-equatorial migrant, spending the summer in the northern hemisphere to breed and wintering in sub-Saharan Africa (Vansteelant *et al.,* 2017). It is largely a woodland species, nesting in trees and flying to more open habitats to find food items, mainly social wasps and bees (Hymenoptera), but also amphibians, reptiles and more rarely birds (Trap-Lind, 1962; Cobb, 1979; McInerny, 2014; Harwood & Richman, 2016).

HISTORY IN SCOTLAND
19th century
For as long as the honey-buzzard has been recorded in Scotland it has always been a rare summer visitor and occasional breeder (Thom, 1986; Forrester *et al.*, 2007). The first dated record was mentioned for the Parish of Hamilton, South Lanarkshire in the *New Statistical Account of Scotland* (1845) with one "shot at Chatelherault in the autumn of 1831" when the species had "not hitherto obtained a place in the Scottish Fauna". Breeding was first reported in Aberdeenshire at two sites: prior to 1840 at Abergeldie and at Ballogie in 1867 (MacGillivray, 1840, 1855; Gray, 1871; Sim, 1903).

20th and 21st centuries
The rare summer visitor and occasional breeding status in Scotland continued during the 20th century until the 1970s when systematic monitoring revealed that nesting occurred in the country every year, although with varying and usually small numbers (Harvey, 2005; Forrester *et al.,* 2007). This trend follows observations elsewhere in the U.K. where originally it was a rare breeder only in southern England, but becoming more widespread in England and Wales since the 1990s (Roberts *et al.,* 1999; Batten, 2001; Roberts & Lewis, 2003; Brown & Grice, 2005; Clements, 2005; Appleby, 2012).

In northern Scotland, a population was found in one area and studied from 1973 to 1986, peaking at 13 occupied sites, with a further seven occupied sites in a second area (Harvey, 2005). Nesting also occurred near Inverness in 1976 and Moray and Nairn in 1977. By the early 1990s the total Scottish population was approximately 22 pairs, this including 15 pairs in northern Scotland with nesting in Ross and Cromarty, Inverness, Badenoch and Strathspey, and Moray and Nairn. In 1992, five successful nests were located further south and east. At this time nesting at two new locations further south in Perth and Kinross and in Dumfries and Galloway was confirmed. Later in the 1990s, the number of breeding pairs detected in northern Scotland dropped to two or three. In 2000, a U.K.-wide survey indicated 14 pairs in Scotland, with four confirmed as breeding (Ogilvie, 2003). By 2004 there were up to 15 occupied sites in northern Scotland supporting 15-20 pairs. By extrapolation, the total Scottish population was estimated to be about 50 pairs in the early 21st century (Forrester *et al.,* 2007).

In central Scotland the honey-buzzard was first recorded in the early 19th century and only occasionally reported through the first half of the 20th century (Shaw *et al.,* 2017). It was not until the late 1980s and early 1990s that it was appreciated that nesting occurred annually, with one or two pairs present. Subsequently, more directed surveying identified one population of up to five territories in east central Scotland with associated non-breeding birds, together constituting up to 16 adults and sub-adults which, in 2016, produced up to seven young (Shaw *et al.,* 2017). Continued monitoring of this population during 2017 revealed an increase to nine territories holding a minimum of 30 birds including up to 18 breeders, at least five non-breeders and seven or

eight juveniles (McInerny *et al.*, 2018; McInerny & Shaw, 2018). A second population in west central Scotland was identified during 2017, containing two or three territories and up to nine birds, including up to six breeders, two non-breeders and one juvenile (McInerny *et al.*, 2018). Surveying elsewhere in central Scotland revealed the presence of up to five isolated territories in potential breeding habitat with nine different birds. Thus, during 2017, central Scotland contained up to 49 honey-buzzards and 17 territories, including up to 24 breeders, seven non-breeders, nine non-assigned birds and eight or nine juveniles.

CURRENT STATUS IN SCOTLAND

Distribution in Scotland

In the early 21st century the honey-buzzard has a fragmented and localised distribution in Scotland. Although breeding pairs are restricted to the mainland, they are present across the country in north, central and southern regions. Typically pairs hold territories in isolation. But in two areas of central Scotland populations have formed, with in one area nine territories and the other two or three territories.

The locations of breeding sites in this paper are deliberately kept confidential to protect the birds from human disturbance and persecution. It is important to emphasise that the honey-buzzard is a Schedule 1 species, meaning that observations should not cause any disturbance and that without an appropriate licence issued by Scottish Natural Heritage (SNH, 2018) nests should not be searched for. The authors of this paper obtained a Schedule 1 licence to complete some of their survey work, the results of which are summarised here.

The breeding season

As a summer breeding visitor, honey-buzzards are present in Scotland from mid-May until mid-September. During this time birds display, establish territories, make nests, lay eggs and raise young. Non-breeders are also present which associate with breeding pairs and populations. A graphical representation of the numbers of honey-buzzards (males, females and juveniles) seen in two areas of central Scotland through the 2017 breeding season is shown in Fig. 1.

Arrival times

Honey-buzzards arrive in Scotland during the second half of May (Fig. 1), although earlier arrivals have been recorded. For example, in central Scotland during 2016, singles were seen at one site on 11th and 14th May, and two were observed elsewhere on 14th May (Shaw *et al.*, 2017). Typically, males arrive first and establish territories with females following one to two weeks later.

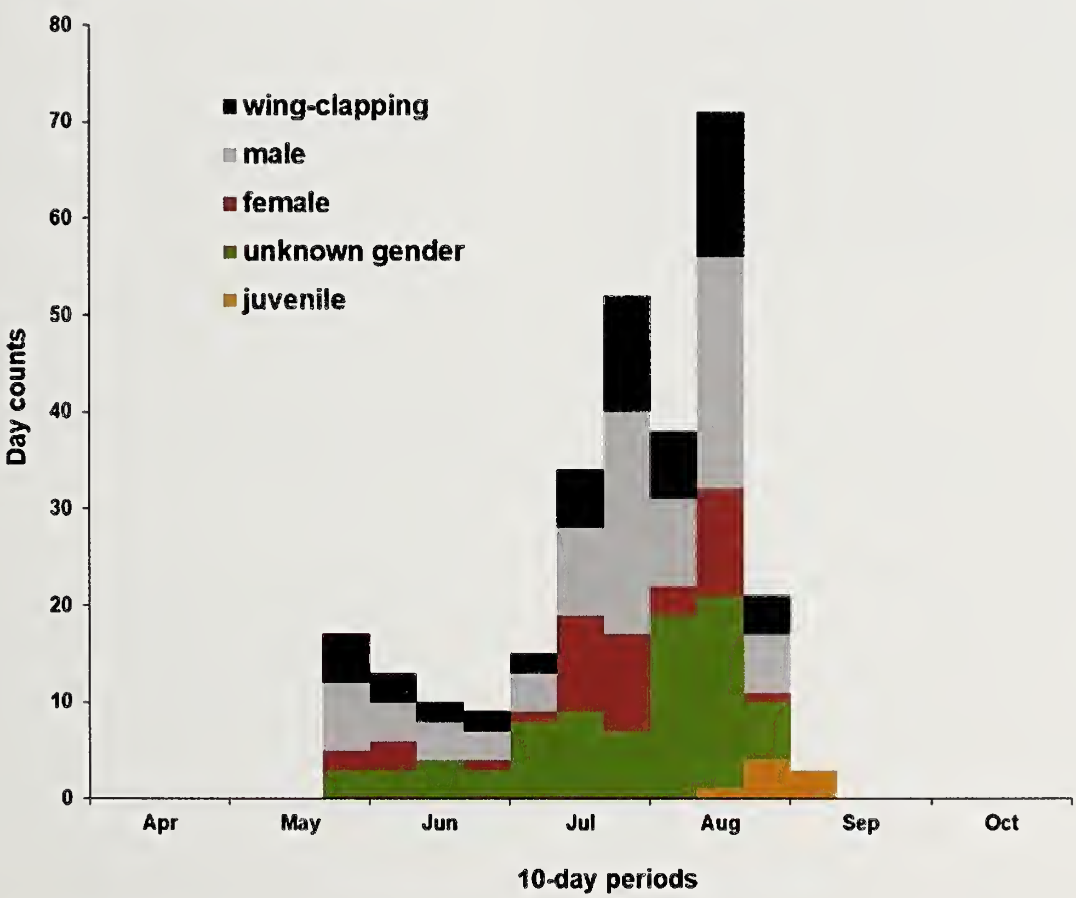

Fig. 1. Numbers of honey-buzzards (*Pernis apivorus*) in central Scotland during 2017. Up to 40 individuals in two populations were identified by plumage differences. The data show "day counts" (the cumulative daily counts of individual birds for each ten-day period from late May to early September), showing males, females, unsexed birds and juveniles separately, along with the wing-clapping displays of both males and females (from: McInerny & Shaw, 2018).

Display and territories
On first arrival males display, establish territory, pair up, and nest usually close to the previous year's nest.

Honey-buzzards have an unusual and characteristic visual aerial display to establish and advertise territories (Roberts & Law, 2014; Harwood & Richman, 2016). Birds actively fly and soar above territorial areas, but during display they perform a wing-clapping butterfly-like flight where the wings are temporarily raised above the body, almost touching, during which the wings quiver (Fig. 2). This movement lasts just two to three seconds before the wings are lowered and the bird flaps again to maintain flight. Such wing-clapping is often repeated, sometimes with over 100 consecutive displays. Both males and females can display, occasionally in response to each other, either low over woods or high in the sky. The wing-elapping can be performed at an extremely high altitude, with birds moving in and out of clouds.

Fig. 2. Displaying male honey-buzzard (*Pernis apivorus*) in central Scotland, August 2017. (Photo: K. Hoey)

Studies have revealed that wing-clapping is mainly for territorial advertisement, rather than courtship between males and females (Roberts & Law, 2014). Where birds are at low densities with isolated territories this results in little display at the beginning of the season. However, where birds are present at higher densities with adjacent and overlapping territories, males (and subsequently females) can be far more active at the start of season after arrival in May and early June with birds displaying, sometimes repeatedly (McInerny & Shaw, 2018) (Fig. 1). Such increased display likely results from birds responding to other birds, in the same way the singing birds will often elicit singing from other nearby birds.

Protracted wing-clapping is more often observed later in the season during July and August (Fig. 1). Such display is mainly due to non-breeders (Roberts & Law, 2014; Shaw *et al.*, 2017; McInerny *et al.*, 2018). Non-breeders display over territories in which they intend to nest in following years, with this often eliciting display from other non-breeding and breeding birds (McInerny, 2014).

Where populations of honey-buzzards form in optimum habitat, nests can be 2-3 km apart with overlap of territories (Voskamp, 2000; Hardey *et al.,* 2013; Gamauf *et al.*, 2013; Shaw *et al.*, 2017; McInerny *et al.*, 2018). This is unlike other woodland raptor speeies, such as northern goshawks (*Accipiter gentilis*), which manage more defined non-overlapping territories, whose perimeters they defend.

Habitat and nests
Honey-buzzards breed in a wide range of woodland habitats throughout the U.K., from ancient broadleaf woodland, mixed broadleaf, to conifer and upland commercial conifer plantations (Roberts & Lewis, 2003; Appleby, 2012; Hardey *et al.,* 2013; Roberts & Law, 2014; Harwood & Richman, 2016).

In Scotland, birds nest in three habitat types: lowland areas of woodland and farmland; upland eommercial conifer plantations; and areas of mixed broadleaf woodland and coniferous forest in the uplands (Forrester *et al.,* 2007; SRSG, 2016). In central Scotland most honey-buzzards have been observed in the last habitat type, with fewer birds found in the two other habitats (Shaw *et al.,* 2017; McInerny *et al.,* 2018) (Fig. 3).

Nests are constructed on the branches of tall trees (Appleby, 2012; Hardey *et al.,* 2013; Harwood & Richman, 2016). Though nests are usually located in woods and plantations, they have also been found in smaller copses and even isolated trees (Clements, 2005).

In northern Scotland, 66% of nests were built in mixed broadleaf and coniferous forest (Forrester *et al.*, 2007). In mixed broadleaf woodland, nests were found predominantly in beech (*Fagus sylvatica*) (55%) and peduneulate oak (*Quercus robur*) (39%), while in eoniferous plantations Douglas fir (*Pseudotsuga menziesii*) (75%) and Scots pine (*Pinus sylvestris*) (19%) were preferred.

Diet
As suggested by their name, honey-buzzards consume social wasps and bees (Hymenoptera) as a major part of their diet (Trap-Lind, 1962; Cobb, 1979; Appleby, 2012; Harwood & Richman, 2016). This includes both adults and grubs in combs, which birds will dig out of holes in the ground or trees. Honey-buzzards appear oblivious to the stings of these insects, apparently obtaining protection from their feathers (Sievwright & Higuchi, 2016).

Fig. 3. Breeding habitat for honey-buzzards (*Pernis apivorus*) in east (A) and west (B) central Scotland. (Photos: C.J. McInerny)

Honey-buzzards also eat other food items when wasps and bees are not available. Common frogs (*Rana temporaria*) and frogspawn are often taken early in the season, with reptiles such as adders (*Vipera berus*), slow-worms (*Anguis fragilis*) and common lizards (*Zootoca vivipara*) also consumed (McInerny, 2014; McInerny *et al.,* 2018). Nestling wood pigeons (*Columba palumbus*) and songbirds have been found in nests (Forrester *et al.*, 2007).

Egg-laying, incubation and young

The average first egg-laying date for honey-buzzards in the U.K. is 2nd June (Roberts & Law, 2014). Clutches of two or three eggs are incubated for around 32 days, hatching in late June or early July. However, occasionally in Scotland, breeding has occurred much later: at a nest in northern Scotland in 1991, a clutch was not laid until early July, four to five weeks later than usual (Forrester *et al.*, 2007).

Birds become very inconspicuous during the incubation period, when pairs are especially secretive as a strategy to protect vulnerable young on nests (Fig. 1) (Roberts & Law 2014).

In central Scotland juvenile honey-buzzards have been observed from 20th August to 6th September (Fig. 1), which is consistent with dates in England, where a range of 31st July to 7th September has been reported (Roberts & Law, 2014), and from early August in other Scottish studies (Forrester *et al.,* 2007).

Breeding success

During the period 1977-2004 breeding data were collected in northern Scotland from 11 locations (Forrester *et al.,* 2007). Of 45 breeding attempts, 42 (93%) were successful. The 79 fledged young resulted from seven broods with one chick, 33 broods of two, and two broods of three, giving a mean of 1.9 chicks/successful pair.

In central Scotland during 2016 seven juveniles were produced from five pairs, suggesting a breeding success of 1.4 chicks/successful pair (Shaw *et al.,* 2017). In 2017, eight juveniles were produced from seven pairs, suggesting a breeding success of 1.1 chicks/successful pair (McInerny *et al.*, 2018). Similar breeding success has been reported elsewhere in the U.K. (Roberts *et al.*, 1999).

Non-breeders

Where honey-buzzards occupy adjacent multiple territories, non-breeding birds associate with breeding pairs. Honey-buzzards do not breed until they are two to three years old (Roberts, 2011; Roberts & Law, 2014) and, although birds remain on the wintering grounds in Africa until they are two years old (Gamauf & Friedl, 2011), over 50% of some breeding populations consist of non-breeders (Clements, 2005).

In central Scotland a number of non-breeders were identified (Shaw *et al.*, 2017; McInerny *et al.*, 2018). These were more visible than breeding birds, as they persistently flew around and between territories, sometimes displaying for up to an hour without pause, with over a hundred consecutive wing-claps. In comparison, breeding birds flew much less and displayed for a much shorter time, typically with only 15-20 wing-claps.

Interactions with other birds of prey

A number of other raptor species have been observed in Scotland that either breed within or otherwise use areas occupied by honey-buzzards, with some interactions noted (Shaw *et al.*, 2017; McInerny *et al.*, 2018).

In central Scotland raptors regularly seen in honey-buzzard territories include golden eagle (*Aquila chrysaetos*), osprey (*Pandion haliaetus*), red kite (*Milvus milvus*), common kestrel (*Falco tinnunculus*), peregrine (*F. peregrinus*), northern goshawk, Eurasian sparrowhawk (*A. nisus*) and common buzzard (*Buteo*

buteo). More rarely hen harrier (*Circus cyaneus*), Eurasian hobby (*F. subbuteo*), merlin (*F. columbarius*) and white-tailed eagle (*Haliaeetus albicilla*) have been recorded.

However, only four raptors have been observed to interact with honey-buzzards: common buzzard, northern goshawk, Eurasian hobby and osprey. The most frequent behaviour was interactions with common buzzards, sometimes flying together, but also with common buzzards aggressively chasing honey-buzzards. Honey-buzzards were also seen to soar and wing-clap with common buzzards a number of times. Northern goshawks, both juvenile males and juvenile females, were seen to interact and harass honey-buzzards on a number of occasions. More rarely hobbies were seen to fly with honey-buzzards. On two occasions interactions with an osprey were observed with birds flying together, and an osprey once harassing a honey-buzzard to which the honey-buzzard wing-clapped in response.

Departures

Honey-buzzards depart from Scotland from late August, with adults leaving before juveniles (Fig. 1). Adults have been seen associating with juveniles, but have departed by the first week in September. Juveniles remain for a week or so after the adults with the last noted in central Scotland on 11th September 2016. These observations accord with studies elsewhere in the U.K.: in Yorkshire birds typically remain until 11th September, with an unusually late individual on 22nd September (Appleby, 2012).

The migration of honey-buzzards from Scotland to their African wintering grounds has been studied by satellite-tracking, which has revealed much interesting information (Forrester *et al.*, 2007). An adult which left breeding areas in Easter Ross on 5th September 2002 took a southerly route passing through England, western France and eastern Spain before crossing the Mediterranean, North Africa and the Sahara. It then passed through West Africa, finishing in coastal woodlands of Gabon on 28th October, a migration lasting almost two months. A tagged juvenile also followed this route, leaving in mid-September, though the transmitter failed in Morocco in late October. However, two other juveniles took a more wayward south-westerly course. One departed in late September and spent a month in Ireland before heading out into the Atlantic Ocean on 29th October when its radio stopped transmitting. Another departed in mid-September, only three weeks after fledging. It moved into the Atlantic Ocean having left south Wales on 23rd September. This young bird then flew non-stop for over four days and nights to travel about 5,000 km over the sea before finally perishing at sea 300 km from Madeira.

Similar migration strategies have been mapped by satellite-tracking of birds in continental Europe. These studies have shown that adult and juvenile honey-buzzards follow different routes during autumn migration, and that individuals change migration strategy during their lifetime (Hake *et al.*, 2003; Vansteelant *et al.*, 2017). Juveniles take longer to migrate, having shorter flights, and showed a larger directional scatter, with wind and geography postulated to influence their first migration south.

Migrants

As well as being a rare breeding species, the honey-buzzard is also a rare passage migrant, with birds from the Continent seen in Scotland on passage between their wintering and summering areas. Migrants are usually observed along the east coast and in Shetland and Orkney, both in spring and autumn. Honey-buzzards appear to cross water more readily than other raptor species (Agostini *et al.*, 2015, 2016).

Larger numbers have been seen occasionally when meteorological conditions on the Continent have displaced migrating birds across the North Sea. For example in 2000 there was an exceptional autumn influx, with an estimated 1,879 in eastern and southern England between 20th September and 1st October (Fraser & Rogers, 2002; Brown & Grice, 2005). In the same period a smaller passage occurred in Scotland including 26 recorded between Shetland and the Borders, with birds west to Dumfries and Galloway.

Wintering areas

Honey-buzzards migrate to West Africa south of the Sahara where they spend the winter in rainforest habitat (del Hoyo *et al.*, 1994; Ferguson-Lees & Christie, 2001). Satellite-tracking has revealed that adults migrate directly to wintering sites where they remain within restricted territories (Strandberg *et al.*, 2012). Conversely, immatures perform extensive movements within the tropics travelling large distances between wintering sites.

Immatures remain in wintering areas until they are two years old (Gamauf & Friedl, 2011), and migrate north to breed when they are three years or older (Roberts, 2011; Roberts & Law, 2014).

Scottish population numbers and trends

The numbers of honey-buzzards in Scotland appear to be increasing, although trends may be obscured as, being very secretive, the species is likely to be under-recorded. Furthermore, the numbers detected are also influenced by observer effort, which has fluctuated over the years.

In central Scotland the most recent population estimate for 2017 suggested up to 49 birds and 17 territories, including up to 24 breeders, seven non-breeders, nine non-assigned birds and eight or nine juveniles (McInerny *et al.*, 2018). These numbers are an increase from 2016 when 23 birds were recorded, including 16 breeders and non-breeders and seven juveniles (Shaw *et al.*, 2017). In years previous to 2016 even fewer were detected, despite similar observer effort, so it is possible that numbers are increasing, at least in central Scotland.

Such changes may reflect similar increases in breeding numbers and expansion of ranges both in England (Appleby, 2012; Harwood & Richman, 2016) and Wales (Roberts *et al.*, 1999). However, on the near Continent in north-west Europe populations have been experiencing declines (Bijlsma *et al.,* 2012). These observations suggest that the recent increases in Scotland are more likely to be due to birds colonising from the expanding U.K. populations, rather than from Europe.

Honey-buzzards also breed in other regions of northern and southern Scotland, with these likely to contain a further 10-20 pairs. Thus the total Scottish population in 2017 may be in the range of 30-50 pairs, similar to that suggested for the early 21st century when the national population was estimated to be 50 pairs (Forrester *et al.*, 2007).

FUTURE PROSPECTS

The recent apparent increase in the central Scotland populations is encouraging for the species' prospects in Scotland. We plan to continue surveying the two populations to see if this trend continues, but also to discover more about these fascinating raptors. Future research will involve locating nests and monitoring productivity. We also wish to survey other potentially suitable habitat in central Scotland as it possible that the honey-buzzard is present elsewhere but undetected due to its rarity, and secretive and elusive nature.

ACKNOWLEDGEMENTS

We thank Kris Gibb, Rick Goater, Keith Hoey, Bruce Kerr, Ali Little, Kenny Little, John Nadin and numerous other co-workers who have collaborated with us to study honey-buzzards in central Scotland. We thank Keith Hoey for permission to use the photograph shown in Fig. 2. To support the fieldwork CJMcI received a travel grant from the Glasgow Natural History Society, Professor Blodwen Lloyd Binns Bequest; and KDS received a travel grant from the Scottish Ornithologists' Club. We thank an anonymous reviewer for improvements to the text.

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The Glasgow Naturalist (2019) Volume 27, Part 1, 27-31

The establishment of Scotland's rarest freshwater fish, the vendace (*Coregonus albula*), in conservation refuge sites

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ABSTRACT
In recent decades conservation measures for the rarest freshwater fish in the U.K., the vendace (*Coregonus albula*), have included attempts to form conservation refuge populations in Scotland. Here we report that at two of these refuge sites where the status of the introduced vendace was previously unknown (Loch Earn and Daer Reservoir) surveys have established that vendace are reproducing successfully *in situ*, albeit that these populations appear to be relatively numerically small. At a third site, Loch Valley, there was no evidence of vendace in the survey, but it is possible that a small, but as yet undetectable population is in the process of establishing.

INTRODUCTION
The vendace is the rarest freshwater fish in the U.K., having only ever been recorded in historical times from four locations. Two of these are in the English Lake District: Bassenthwaite Lake and Derwent Water; and two in southern Scotland: Castle Loch and Mill Loch, adjacent to the town of Lochmaben in Dumfriesshire (Maitland, 2007) (Fig. 1). Of these, the Bassenthwaite Lake population was thought to have been lost in 2008 (Winfield *et al.*, 2012), as a result of eutrophication of the lake, sedimentation of the vendace spawning grounds and the introduction of non-native fish species, although there is now evidenee of their re-establishment there, most likely by re-colonisation by vendace from Derwent Water which has a direct river connection into Bassenthwaite Lake (Winfield & Gowans, 2014; Winfield *et al.*, 2017). In Scotland, both native vendace populations have been lost. The Castle Loch population in the early 20th century, mostly likely as the result of eutrophieation from a new sewage works; the Mill Loch population sometime between 1966 and around 1975, also mostly likely as the result of eutrophication but in this case from diffuse pollution (Maitland & Lyle, 2013).

The rarity of vendace in the U.K. and the loss of three of the four known historical populations, including both Scottish populations, prompted the then Nature Conservaney Council in 1986 to initiate conservation management actions which included efforts to establish new vendace populations in selected sites, to which they were not native, to act as conservation refuge or "Ark" sites. Since 1996, Scottish Natural Heritage and the Environment Agency (England) have promoted, through the U.K. Biodiversity Action Plan Steering Group (Vendace), a continuation of the vendace conservation programme and there are now five water bodies where attempts to create refuge populations have been made: Loch Earn, Daer Reservoir, Loch Valley and Loch Skeen in Scotland, plus Sprinkling Tarn in Cumbria (Fig. 1).

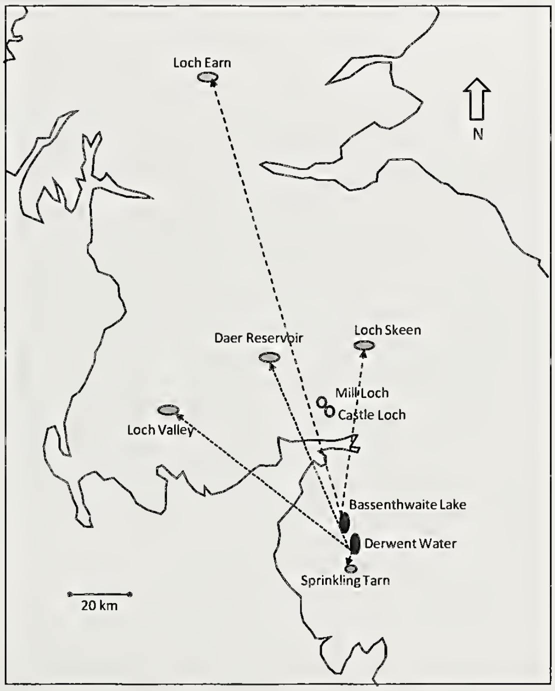

Fig. 1. A map showing the locations of the vendace (*Coregonus albula*) source population sites: Bassenthwaite Lake and Derwent Water in the English Lake District, Cumbria; and the conservation refuge sites: Loch Earn, Daer Reservoir, Loch Valley and Loch Skeen in Scotland, plus Sprinkling Tarn in Cumbria. The locations of the now extinct Castle Loch and Mill Loch vendace populations in Scotland are also shown.

The translocation of 17,550 fry and 47,500 eyed eggs to Loch Skeen between 1997 and 1999 has resulted in an established, self-sustaining population of vendace there and is fully reported elsewhere (Maitland & Lyle, 2013;

Adams *et al.*, 2014). The success of the vendace introduction to Sprinkling Tarn remains unknown.
Here we report on recent surveys at the other three conservation refuge sites to investigate the status of vendace there.

METHODS

Previous attempts to assess whether fish translocations have been successful in Scotland have relied on the use of gillnetting and hydroacoustie approaches (Maitland *et al.*, 2003, 2007). This was based on the understanding that fish are more active and susceptible to capture in gill nets during summer periods, and that vendace occupy the pelagic zone of standing waters at night and are easy to detect and count using hydroacoustic techniques.

The approach taken for Loch Earn and Daer Reservoir differed from this in that surveys were undertaken during the known spawning periods for vendace in the U.K., and sampling effort was targeted towards habitats that matched the spawning substrates considered to be similar to those used elsewhere (Coyle & Adams, 2011). The survey at Loch Valley, however, was conducted in summer since winter access to this more remote upland loch could be uncertain.

Loch Earn (NN644237)

Loch Earn, in Perthshire, is one of the larger Scottish lochs. It has a surface area of 1,013 ha, a maximum depth of 87.5 m and a mean depth of 42.0 m (Murray & Pullar, 1910). It has a length of 10.4 km and an average width of about 1 km and lies at an altitude of 97 m aod (Fig. 2).

Loch Earn was surveyed between 27th and 29th November 2016 during the vendace spawning period. Single mesh monofilament benthic gill nets (30 m x 1.5 m and 30 m x 3.0 m) of mesh sizes likely to capture adult vendace (i.e. 18.5, 22 and 25 mm mesh, knot-to-knot) were used and set overnight - six nets on 27th/28th and four nets on 28th/29th. These nets were set onto the loch bed in littoral and sub-littoral zones of the loch (2-12 m depth) in areas which appeared to be suitable vendace spawning sites (comprising well washed gravel to cobble sized substrate) (Fig. 2).

Daer Reservoir (NS980086)

Daer Reservoir lies in the Lowther Hills in Lanarkshire within the River Clyde catchment. It is a public water supply controlled by Seottish Water. The reservoir measures 202 ha in surface area, with a maximum depth of 37.1 m and lies at an altitude of 342 m aod (Fig. 3). Daer Reservoir was surveyed on 5th/6th December 2017 during the spawning period for vendace. A combination of benthic Norden survey gill nets (Appelberg *et al.*, 1995) (see below) and single mesh size nets (30 m x 1.5 m and 18.5, 22 and 25 mm mesh sizes) were used. Five nets (two Norden nets and one each of the three single mesh size nets) were deployed at sites that appeared suitable for vendace spawning (well washed gravel to cobble sized substrate) in water depths of 4-19 m on the 5th December, left overnight and retrieved the following morning (Fig. 3).

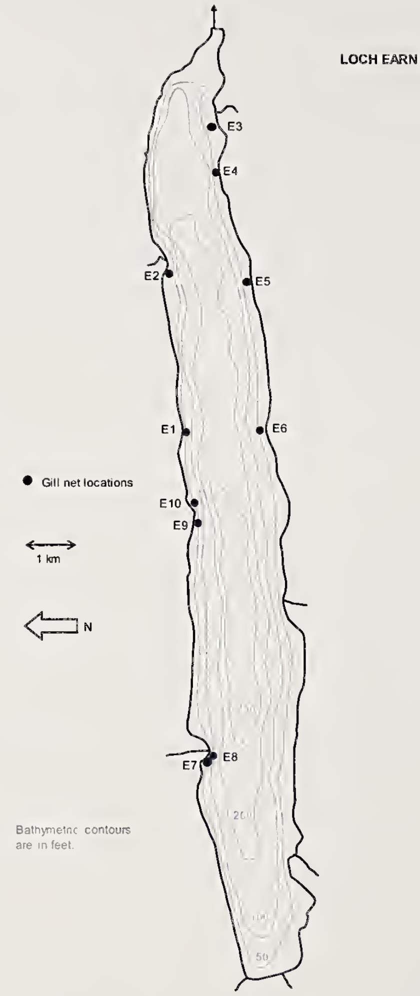

Fig. 2. Loch Earn, Scotland showing the 10 benthic gill net locations (E1-E10) used in the survey. Depth contours are in feet (derived from Murray & Pullar, 1910).

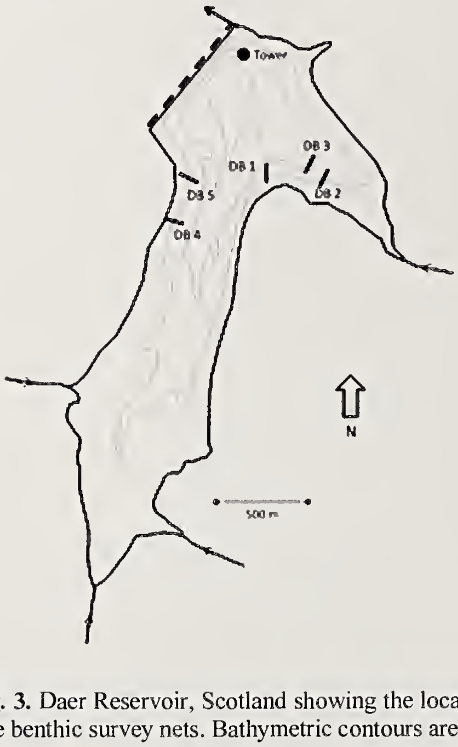

Fig. 3. Daer Reservoir, Scotland showing the locations of the five benthic survey nets. Bathymetric contours are in metres.

Loch Valley (NX444817)
Loch Valley is located in the Galloway Forest Park in southwest Scotland. The loch is 35.8 ha in area with a maximum depth of 17.2 m and lies at an altitude of 322 m aod (Fig. 4).

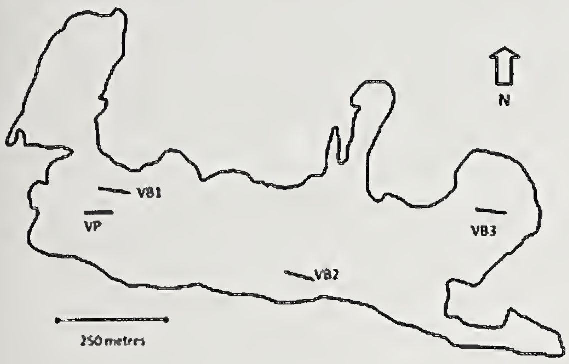

Fig. 4. Loch Valley, Scotland showing the locations of the four survey net sites (VP= pelagic, VB= benthic).

Loch Valley was surveyed during the summer feeding period for vendace. The survey was conducted overnight on 3rd/4th July 2017 using three Norden benthic survey gill nets (30 m x 1.5 m) set onto the loch bed, and one Norden pelagic net (27.5 m x 6 m) set at the water surface. Norden net types comprise 12 (benthic) and 11 (pelagic) panels with mesh sizes 8-55 mm knot-to-knot (Appelberg *et al.*, 1995). The survey here was deliberately of low intensity to avoid any undue impact on a potentially newly establishing fish population (Fig. 4).

Full details of these surveys are given in the official reports to Scottish Natural Heritage: Adams & Lyle (2017) for Daer Reservoir and Loch Valley, and Lyle & Adams (2016) for Loch Earn.

RESULTS

Loch Earn
Gill netting surveys at Loch Earn captured brown trout (*Salmo trutta*) (N = 186), Arctic charr (*Salvelinus alpinus*) (N = 21), and a single vendace. The vendace was 209 mm fork length and a 5+ years old male which was exuding sperm indicating that it was in spawning condition at that time.

Daer Reservoir
Gill netting surveys at Daer Reservoir recorded brown trout (N = 37) and a single vendace (Fig. 5) which was collected in the 25 mm single mesh size net. The vendace was 211 mm in length and weighed 105 g and was a female that had recently spawned.

Loch Valley
Surveying at Loch Valley recorded brown trout (N = 25) but no vendace were found.

Fig. 5. The first vendace (*Coreginus albula*) recorded at the Daer Reservoir, Scotland conservation refuge site in 2017. (Photo: C.E. Adams)

DISCUSSION

Background - conservation translocations at the refuge sites

The methodology of refuge site selection and practical translocations of vendace for conservation management in Scotland have been reported more fully elsewhere (Maitland & Lyle, 1990, 2013; Adams *et al.*, 2014), but a brief summary of relevant elements for the three sites examined in this study is given here.

Loch Earn In 1989, 8,400 vendace fry from the Bassenthwaite Lake population were introduced into Loch Earn (Maitland & Lyle, 1990). There were no subsequent reports of vendace having established there from (unconnected) netting surveys by others, or by anglers, until a single specimen was caught by an angler in 2005. Consequently, a dedicated gill netting and hydroacoustic survey was carried out in 2007 (Maitland *et al.*, 2007) but vendace were not detected. A second vendace was reported caught by an angler in 2012 and in 2016 the survey for vendace reported here was commissioned by Scottish Natural Heritage.

Daer Reservoir Translocations of vendace from the Derwent Water population were made to Daer Reservoir in 1998, 2005 and 2008. In total 25 adults, 12,800 unfed fry and 32,300 eggs were transferred. Extensive gill netting surveys in 2003 (Maitland *et al.*, 2003) and again in 2009 (Lyle *et al.*, 2009) both failed to deteet any vendace and the status of the conservation translocation population remained uncertain. In 2017 Scottish Natural Heritage commissioned a further survey, the results of which are given above.

Loch Valley An introduction of vendace to this site was carried out in 1968 but it failed to establish probably due to acidification (Maitland *et al.*, 2013). Water quality monitoring by Marine Scotland Science has shown that water quality (pH) has shown a consistent recovery from acidification and is now able to support salmonid fish (Harriman *et al.*, 2003).

In 2011, 70,000 eyed eggs collected from spawning vendace from Derwent Water were translocated to Loch Valley (Lyle & Dodd, 2011). Prior to the survey reported above, there had been no attempt to assess the status of this translocation.

Conclusions from this survey

Loch Earn

Although only a single vendace was collected from Loch Earn, this result shows that a population of vendace has established and that it has survived for over 27 years, equivalent to at least nine generations since translocation to this location in 1989. Although this survey does not provide for a robust analysis of vendace population size, the very low catch rate eompared with that of brown trout and Arctic charr and the absence of any vendace in the 2007 survey (Maitland *et al.*, 2007) suggest that only a very small population of vendace has established in Loch Earn.

Daer Reservoir

Although three separate introductions of vendace were made to Daer Reservoir over a ten-year period (1998-2008) and by different means of material transfer (adults, fry and eggs) it cannot be concluded which of those transfers or methods was successful. However, since vendace live for five to six years (Maitland & Campbell, 1992), the capture of even a single specimen indicates that there has been successful reproduction for at least three generations of vendace in Daer Reservoir since the last translocation in 2008. The indications from this survey are that the population is currently relatively small and if it was one of the later translocations that was first successful it is possible that the population is only now in the process of fully establishing itself.

Loch Valley

The lack of a record of vendace at Loch Valley does not necessarily lead to the conclusion that vendace have not established there. It is exceedingly difficult to establish presence or absence of any animal that is possibly at low abundance with any low intensity survey technique. The earlier, very extensive and intensive surveying of Loeh Earn indicates how easy it is to miss detection of a numerically small fish population. It remains possible that the vendace introduction to Loch Valley, which was made only six years (*ca.* two generations) before the survey reported here, has established a small but as yet undetected population.

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The Glasgow Naturalist (2019) Volume 27, Part 1, 32-38

New records of the lancelet *Branchiostoma lanceolatum* in Scottish waters

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ABSTRACT
New records of the lancelet *Branchiostoma lanceolatum* from Scottish waters are presented. Most of the records originate from sublittoral monitoring around fish farms from Orkney, Shetland, the Western Isles, the Isles of Skye and Mull, but also from a distillery discharge in the Firth of Clyde and a plankton survey in the Sea of the Hebrides. Lancelets were recovered in sediment grab samples from 6-60 m depth. Some recent accounts of intertidal lancelets are also cited. The lancelets appear to prefer coarser sediments and in the fish farm surveys were found predominantly at reference sites, away from the immediate influence of farm deposition.

INTRODUCTION
The lancelet *Branchiostoma lanceolatum* (Pallas, 1774) is an obscure, vaguely fish-like creature, up to 8 cm long, which lives buried in sand or coarse sediments in British seas. Its body is laterally compressed, pinkish white in colour, and pointed at both ends with a lance-like tail fin (Fig. 1). There are no paired fins, nor eyes, nor even a well-defined head, and it has only a small mouth surrounded by cirri, used to filter organic matter from the surrounding water. It has a dorsal notochord and segmented muscle blocks allowing it to swim in a sinusoidal fish-like manner, but no backbone, and it is therefore classified as an invertebrate (Barnes, 2015).

Lancelets are characteristic of sublittoral coarse sediments, so much so that a specific seabed habitat, "Amphioxus Sand" has been named after them, under their older genus name of *Amphioxus* (Pérèz & Picard, 1964; De Biasi & Boni, 2002). Nowadays, under the Marine Habitat Classification for Britain and Ireland, this biotope is known in full as "SS.SCS.CCS.Blan - *Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel" (JNCC, 2018). Lancelets have a larval stage that lives for a short time within the plankton. The larvae metamorphose when around 3.5–5.0 mm long and the juveniles then settle on the seabed (Wickstead, 1967; Geise & Pearse, 1975).

In U.K. waters, they are considered to be a southern species, with most records from south England and Wales. However, they have also been recorded off eastern England and Northern Ireland. They appear to be scarcer in Scottish waters with only scattered records on the west coast and in Orkney and Shetland (NBN, 2018).

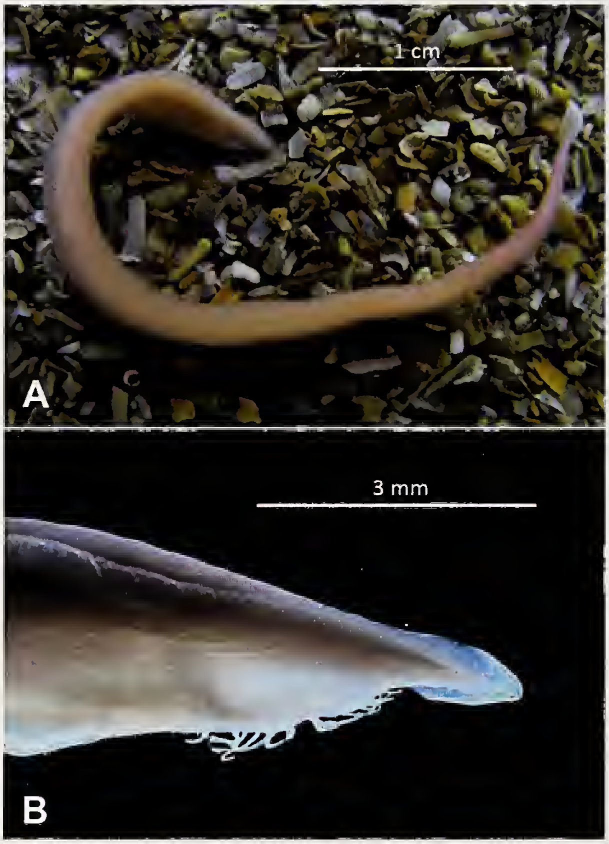

Fig. 1. The lancelet *Branchiostoma lanceolatum.* (A) A specimen captured in a SEPA survey in Laxfirth Voe, Shetland, 2011. The anterior is towards the left. (B) Anterior of the same lancelet showing the cirri around the mouth. (Photo: SEPA)

Records on the east coast of Scotland appear to be very sparse. The *Fauna and Flora of St. Andrews Bay* holds only one old record of a lancelet, from the stomach of a cod (Laverack & Blackler, 1974).

Lancelets represent an evolutionary precursor of fish. They may be related to conodonts, enigmatic fossils, known from Carboniferous rocks in Scotland (Bergstrom *et al.*, 1998; Knell, 2012). Fossils very similar to lancelets are known from the Cambrian period, at the dawn of vertebrate evolution. These include *Pikaia gracilens* from the famous Burgess Shale fauna in Canada (Gould, 1989; Briggs *et al.*, 1994; Conway Morris, 1998) and *Myllokunmingia fenjiaoa*,

one of the earliest putative vertebrates, from Chengjiang in China (Xian-Guang *et al.*, 2017). Hence, lancelets are among a disparate group of "living fossils", which are known from the early fossil record and have survived, almost unchanged, for millions of years (Fortey, 2011).

They have long been an important model of vertebrate ancestors for university students studying evolution, and are still cultured for developmental biology studies (Desdevises *et al.*, 2011; Theodosiou *et al.*, 2011). However, outside of academia they are poorly known and frequently overlooked. Indeed *Branchiostoma lanceolatum,* the only laneelet species that occurs in British waters, was inadvertently omitted from the directory of British marine fauna and flora (Howson & Picton, 1997).

SURVEY AND METHODS

In recent years, news snippets have highlighted occasional finds of lancelets in surveys by the Scottish Environment Protection Agency (SEPA) and Marine Scotland in Shetland and Orkney (O'Reilly, 2011; BBC, 2011). Some lancelets have also been found by others on shore surveys. One was captured at Cellardyke, Fife, during a Scottish Fisheries Museum children's rock pool guddle (Simon Hayhow & Dr Richard Shelton, pers. comm. 2010); and two were spotted at Ord in Loch Eishort, Skye, at low tide on exposed maerl gravel, in a survey by South Skye Seas Initiative (Bailey, 2016; Skye Times, 2016).

Although lancelets have been regarded as rarely seen in Scottish waters, fish farm surveys carried out by SEPA and by farm operators have revealed numerous additional records, with further finds in similar surveys around a distillery discharge near Girvan.

SEPA requires fish farm operators to undertake self-monitoring surveys of the seabed and since 2006 the survey data have been imported to a SEPA Fish Farm database. The database holds records from 2006 including 1,480 surveys with data from over 10,000 sampled stations with two, three, or five grabs at each station, depending on grab size. The benthic monitoring undertaken by the fish farm industry followed guidance outlined in SEPA's *Fish Farm Manual*. The manual was first issued in 1998 and the monitoring protocols have recently been updated (SEPA, 2017).

Benthic grab samples for macrofauna assessment are collected and sieved in the field on 1 mm mesh sieves to remove fine sediments, and the sieve residue is retained and fixed with the addition of formaldehyde solution. In the laboratory the samples are rinsed on 1 mm sieves to remove the formaldehyde. The residue is washed into trays and spread out to allow all the macrofauna to be picked out with forceps and placed in vials with preservative (industrial methylated spirit). All the macrofauna specimens are identified and counted with the aid of stereo and compound microscopes and standard taxonomic identification literature. The procedures for analysing macrofauna samples are now aligned with guidance laid down by the NMBAQC Scheme (Worsfold *et al.*, 2010).

Most of the lancelet records derive from standard fish farm surveys with four stations sampled along a transect from the cage edge up to 100 m distance, and with two reference stations sampled at least 500 m away from the cages. The samples containing lancelets were collected in the sublittoral zone using grabs, usually 0.025 m^2 or 0.02 m^2 Van Veen grabs, but also 0.45 m^2 Van Veen grabs, and occasionally 0.1 m^2 Day or Hamon grabs. Usually five 0.025 m^2 or 0.02 m^2 replicate grabs were collected per station, but only three replicates for 0.45 m^2 grabs or two for 0.1 m^2 grabs. A couple of larval lancelets were colleeted during a SEPA plankton survey using a paired Bongo net (23 cm diameter nets of mesh size 63 μm and 200 μm) hauled vertically from 45 m depth.

NEW LANCELET RECORDS

In order to augment knowledge of lancelet distribution in Scottish seas, all the lancelet records held by SEPA have been collated and are presented, arranged geographically (approximately north to south), in Appendices 1-3. There are over 70 new records from 59 different surveys, predominantly from Orkney and Shetland, but also from Eddrachillis Bay, Sutherland, the Western Isles, the Sea of the Hebrides, the Isles of Skye and Mull, and from Girvan in the Firth of Clyde.

The average depth of the grab sampling was around 20 m, ranging from 6-60 m. The sediment descriptions are generally coarse, ineluding sands, grit, shale, shell gravel, maerl, and stones, and are mostly consistent with the SS.SCS.CCS.*Blan* biotope typical for lancelets. The depth range of the new lancelet records, up to 60 m, is deeper than the depths of "sublittoral to 30 m" quoted by Barnes (2015) and is more consistent with the depths of up to 80 m found by De Biasi & Boni (2002). Cabioch (1961) found lancelets down to 100 m depth off Roscoff, Brittany, France.

The two SEPA records from the Sea of the Hebrides were for larval lancelets collected during plankton sampling. As the net is hauled from 45 m depth, the larvae could have been at any depth between 0 and 45 m. The bathymetric depth at this site is around 90 m so, either way, these particular larvae were a considerable distance from the seabed.

On most grab sampling occasions, only a single lancelet was captured per grab sample, but sometimes a 0.045 m^2 grab captured two lancelets. The most productive survey location by far was in the Sound of Hellisay, Barra, where, in a baseline survey in December 2010, 49 lancelets were captured in ten 0.1 m^2 Day grabs, with two grabs capturing ten lancelets each. The mixture of mobile maerl and sand here seems to be favoured, with lancelets found at all five stations within the vicinity of the then proposed Hellisay fish farm. However, once the fish farm was established, subsequent surveys in 2013, 2015, and 2017 recorded no lancelets.

There appear to be few previous records of lancelets in the Firth of Clyde. The NBN Atlas shows only a single reeord of a single lancelet, from August 2010, recorded in an SNH diving survey off Clauchlands Point, Lamlash Bay, Arran. The new finds of six lancelets from five stations around the Girvan distillery outfall in 2015 and 2016 may represent the most southerly records in Scottish waters.

ANTHROPOGENIC IMPACTS

On most of the fish farm surveys lancelets were found only at the reference sites, indicating they may be intolerant of organic deposition due to aquaculture. Their abundance close to the proposed fish farm at Hellisay in 2010 and subsequent disappearance from this area highlights their sensitivity to fish farm outputs. A study of an Amphioxus Sand community in Greece has shown that populations of lancelets diminish when exposed to organic enrichment, with accumulations of organic detritus altering the composition of all the infaunal community (Antoniadou *et al.*, 2004). However, a study of lancelets in Italian waters found that, although populations had diminished in many areas, they still occurred in some sites with strong human impact with up to 20% silt and elay content in the sediments (De Biasi & Boni, 2002). These authors also suggested that the presence of lancelets might be under-estimated due to their ability to burrow very rapidly in the coarser sediments, thus often avoiding being sampled, and to their unusual seasonal abundance pattern, with populations being reduced in spring and summer, when weather prospects mean scheduling of routine monitoring surveys may be more likely. They believed these biases could lead to inaccurate assessments of their prevalence. Fish farm surveys, which predominate here, are required to be carried out around peak biomass of the farmed fish, which should show no seasonal pattern, yet the surveys with lancelet records are more frequent in spring and summer (12 and 23 surveys) than autumn and winter (14 and 10 surveys). However, as only 4% of fish farm surveys actually recovered any lancelets, it would be unwise to draw any inference on their seasonal occurrence from surveys not specifically targeted towards their capture.

It is evident from the records provided, that lancelets are widely distributed in Scottish coastal waters, including both the intertidal and sublittoral zones. Tidally swept regions with course substrates, including shell gravel and maerl beds, offer a haven for them in many parts of Scotland and their prevalence here may be underestimated. However, both Amphioxus Sand and maerl habitats in which they prosper are potentially at risk from anthropogenic impacts.

Lancelets have been regarded as a southern species in U.K. waters and the preponderance of southern records in the U.K. NBN Atlas (NBN, 2018) supports this view. Indeed the addition of new records in Scottish waters might be considered as an indieator of warming seas. The world distribution of *B. lanceolatum* shown in the Marlin website (Barnes, 2015) implies that Shetland is at the northern edge of its distribution. However, historical records from Norway, collated by Tambs-Lyche (1967), show that its distribution extends further northwards, with a single record from 1906 near Bodø, which lies just north of the Arctic Circle. Hence, the paucity of northern reeords in British waters and elsewhere is most probably just a consequence of limited sampling in suitable habitat.

ACKNOWLEDGEMENTS

Thanks are due to the fish farm companies: Cooke Aquaculture Scotland Ltd., Greig Seafood Shetland Ltd., Loch Duart Ltd., Marine Harvest (Seotland) Ltd., Scottish Sea Farms Ltd., and The Scottish Salmon Company for provision of data and sample analysts at Benthic Solutions (Jake Ganther), Biotikos (Inga Williamson), Fish Vet Group (Kate MeEwen), Marine Farm Services, and Shetland Seafood Quality Control (Alan Harpin), for processing samples and identifying the fauna. The surveys at the Girvan distillery outfall were undertaken by Anderson Marine Surveys Ltd. and SAMS Research Serviees Ltd. and permission to use these data was given by William Grant & Sons Ltd.

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APPENDIX 1. Lancelet (*Branchiostoma lanceolatum*) records from Shetland, Scotland.

Survey	Date	Count	Station	Lat. (North)	Long. (West)	Depth (m)	Sediment description
Wick of Belmont	24/07/08	1	Ref.2	60°41.034'	00°58.101'	8	Coarse sand, very coarse sand, shell gravel.
Tur Ness	30/08/07	1	0-5 m CE	60°40.399'	00°52.964'	11	Medium sand.
Vee Taing	23/03/12	1	Ref.2	60°40.040'	00°55.825'	19	Coarse sand, shell fragments.
Holm of Heogland	20/08/13	1	50 m T2	60°40.027'	00°56.223'	28	Coarse sand, shell fragments.
Holm of Heogland	20/08/13	1	50 m T1	60°39.980'	00°56.332'	29	Shell/maerl fragments.
Winna Ness	27/01/11	1	25 m NW	60°39.981'	00°54.480'	20	Very fine to fine sand, shell fragments.
Winna Ness	15/02/13	1	Ref.1	60°39.979'	00°55.378'	26	Medium sand, shell fragments.
Winna Ness	08/05/15	1	Ref.1	60°39.965'	00°55.877'	22	Medium sand, broken shell.
South Head of Mula	19/10/09	1	Ref.2	60°39.967'	00°55.744'	21	Medium to coarse sand, shell gravel.
Djuba Wick	12/08/08	1	Ref.2	60°37.486'	00°58.586'	21	Coarse sand, shell fragments.
Djuba Wick	28/08/12	1	Ref.1	60°37.327'	00°59.590'	13	Coarse sand, shell fragments with maerl.
Djuba Wick	28/08/12	1	Ref.2	60°37.198'	00°58.303'	19	Coarse sand, shell fragments with maerl.
Bow of Hascosay	04/09/07	1	Ref.1	60°35.862'	01°01.546'	24	Coarse shell sand, maerl
Bow of Hascosay	01/09/09	1	Ref.1	60°37.105'	01°00.346	13	Coarse sand, shell fragments, maerl.
Bow of Hascosay	01/09/09	1	50 m W	60°36.603'	01°00.563	13	Coarse sand, shell fragments, maerl.
Bow of Hascosay	31/08/11	1	Ref.1	60°36.975'	01°00.443'	13	Coarse shell sand, shell fragments, maerl.
Bow of Hascosay	31/08/11	1	Ref.2	60°36.192'	01°01.720'	18	Mixed shell sand, maerl.
Bow of Hascosay	03/06/17	1	350 m N	60°36.907'	01°00.256'	9	Maerl, sand.
Wick of Vatsetter	03/09/07	1	Ref.1	60°35.862'	01°01.546'	24	Coarse sand, shells, stones, maerl.
Wick of Vatsetter	30/08/11	1	Ref.1	60°35.828'	01°01.500'	25	Medium to coarse sand, shell sand.
Wick of Vatsetter	30/08/11	2	Ref.2	60°36.192'	01°01.720'	18	Shell sand, maerl.
Wick of Vatsetter	23/09/15	1	Ref.1	60°35.879'	01°01.630'	22	Fine sand, shell fragments.
Fish Holm	02/09/09	1	Ref.2	60°26.259'	01°07.568'	60	Medium to coarse sand, shell fragments.
Boatsroom Voe	31/08/10	1	Ref.1	60°25.693'	01°06.414'	20	Fine to medium sand, shell fragments.
Laxfirth Voe	03/04/09	1	Ref.1	60°13.456'	01°10.834'	19	Medium Sand.
Laxfirth Voe	09/07/11	1	Ref.3	60°13.457'	01°11.330'	17	Sand and shell.
Laxfirth Voe	29/05/15	1	Ref.1	60°13.484'	01°10.820'	18	Fine to coarse sand, shell fragments, maerl fragments.
Laxfirth Voe	21/11/16	2	Ref.1	60°13.480'	01°10.798'	18	Fine or very fine sand, shell fragments, maerl fragments.
Spoose Holm	03/9/08	1	Ref.1	60°07.964'	01°21.270'	22	Shell gravel.
Spoose Holm	03/8/13	3	Ref.1	60°07.963'	01°21.269'	22	Fine to medium sand, shell fragments.
Spoose Holm	09/9/17	1	Ref.1	60°07.918'	01°21.473'	27	Medium to coarse sand, shell fragments.
Teisti Geo, Clift Sound	20/6/17	1	Ref.2	60°02.583'	01°19.473'	24	Sandy gravel.

APPENDIX 2. Lancelet (*Branchiostoma lanceolatum*) records from Orkney, Scotland.

Survey	Date	Count	Station	Lat. (North)	Long. (West)	Depth (m)	Sediment description
Ouse Ness	21/05/15	1	Ref.2	59°19.405'	02°56.877'	13	Medium sand, shell fragments.
Bay of Cleat	14/12/10	2	Ref.2	59°18.663'	02°55.054'	13	Medium sand, fine shell fragments, maerl.
Bay of Cleat	08/08/12	1	25 m SE	59°18.612'	02°55.536'	13	Maerl, coarse shell sand.
Bay of Cleat	09/10/14	1	25 m NW	59°18.747'	02°55.725'	17	Fine sand, some maerl fragments.
Eday Sound	03/02/12	1	Ref.1	59°09.467'	02°44.647'	19	Sand, shell, gravel and maerl.
Eday Sound	01/05/13	2	50 m SE	59°09.585'	02°45.037'	17	Shelly sand.
Eday Sound	01/05/13	1	100 m SE	59°09.557'	02°45.022'	16	Shelly sand.
Kirk Noust, Rousay Sound	17/05/13	1	Ref.1	59°09.077'	02°57.652'	15	Fine sand, shell fragments, some maerl.
Kirk Noust, Rousay Sound	16/06/16	1	Ref.N	59°09.129'	02°57.179'	10	Sand, maerl.
Wyre	06/12/16	1	Ref.4	59°06.516'	02°58.990'	31	Fine sand.
Puldrite Bay	24/04/08	1	Ref.1	59°03.002'	02°59.890'	15	Fine sand, maerl fragments.
Carness Bay	11/05/10	1	Ref.2	59°00.732'	02°54.797'	13	Coarse sand, shell fragments, stones, some maerl.
Carness Bay	18/10/16	1	Ref.2	59°00.609'	02°55.121'	6	Coarse sand, shell sand.
Carness Bay	08/09/17	1	Ref.2	59°00.620'	02°55.128'	19	Fine sand, shell sand.
Yinstay East	20/01/18	1	200 m E	58°59.568'	02°49.344'	20	Maerl, fine to medium sand, shell fragments.
Scapa Flow	25/05/14	1	W of Houten Head	58°54.576'	03°13.902'	42	Mud, maerl and stones.

APPENDIX 3. Lancelet (*Branchiostoma lanceolatum*) records from western Scotland.

Survey	Date	Count	Station	Lat. (North)	Long. (West)	Depth (m)	Sediment description
Calbha Beag, Eddrachillis Bay	24/06/10	1	50 m NNE	58°17.088'	05°08.870'	25	Sand and shell.
Oldany Island, Eddrachillis Bay	22/08/11	1	Ref.2	58°15.246'	05°16.561'	22	Sand, shell.
Oldany Island, Eddrachillis Bay	17/02/16	1	T1 Ref.2	58°14.933'	05°16.256'	42	Mud, sand, and shell.
Loch Euphort, North Uist	10/08/10	1	Ref.2	57°33.331'	07°09.803'	18	Medium shell sand.
Loch Euphort, North Uist	11/04/12	1	38 m AZE	57°33.374'	07°10.061'	34	Shale.
Loch Euphort, North Uist	12/02/14	2	Ref.1	57°33.316'	07°09.479'	21	Mud, stones.
Greanamul, Benbecula	25/08/15	1	Ref.1	57°24.638'	07°11.180'	17	Shale.
Petersport, Benbecula	28/07/10	3	Ref.1	57°23.198'	07°13.707'	17	Mud, shell, and sand.
Petersport, Benbecula	28/07/10	1	Ref.2	57°23.402'	07°14.076'	11	Mud, shell, and sand.
Petersport, Benbecula	14/02/17	1	Ref.1	57°23.407'	07°14.144'	15	Sand and gravel.
Petersport, Benbecula	12/07/17	1	Ref.1	57°23.407'	07°14.144'	16	Sand, gravel, and shells.
Hellisay, Barra	17/12/10	8	0 m	57°00.345'	07°20.354'	26	Maerl, sand.
Hellisay, Barra	17/12/10	18	100 m W	57°00.357'	07°20.462'	29	Maerl, sand.
Hellisay, Barra	17/12/10	3	200 m W	57°00.374'	07°20.532'	28	Maerl, sand.
Hellisay, Barra	17/12/10	14	100 m E	57°00.342'	07°20.297'	27	Maerl, sand.
Hellisay, Barra	17/12/10	6	200 m E	57°00.356'	07°20.201'	24	Maerl, sand.
Loch Portree, Skye	30/09/15	2	Ref.2	57°24.680'	06°09.361'	41	Mud, sand.
Sea of Hebrides	17/08/15	1	South @ Stn. 2	56°51.011'	06°27.721'	0-45	Plankton.
Sea of Hebrides	02/09/15	1	South @ Stn. 2	56°51.011'	06°27.721'	0-45	Plankton.
Geasgill, Mull	12/05/06	1	50 m W	56°27.709'	06°10.247'	19	Shells, grit, and stones.
Girvan, Firth of Clyde	Aug-15	1	Stn.7	55°16.012'	04°51.596'	11	Very coarse sand.
Girvan, Firth of Clyde	Aug-15	2	Stn.18	55°16.093'	04°51.394'	7	Very coarse sand.
Girvan, Firth of Clyde	Aug-15	1	Stn.23	55°16.123'	04°51.621'	11	Coarse sand.
Girvan, Firth of Clyde	29/07/16	1	Stn.31A	55°16.403'	04°51.609'	13	Mixed sediment.
Girvan, Firth of Clyde	29/07/16	1	Stn.31B	55°16.416'	04°51.609'	13	Mixed sediment.

The Glasgow Naturalist (2019) Volume 27, Part 1, 39-44

Behind the Naturalist's Lens – Celebrating the life and contribution to natural history of Charles Eric Palmar (1920-1986)

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ABSTRACT

Charles Eric Palmar was Curator of Natural History in Kelvingrove Art Gallery and Museum, Glasgow from 1949 to 1984 and a long-standing member of the Glasgow Natural History Society. This article provides an outline of his life and the major achievements in both his professional career and natural history activities. The latter included pioneering studies on the golden eagles (*Aquila chrysaetos*) of Scotland and made much use of photography and cinematography. A project is currently under way to scan, archive and make publicly accessible many of his photographs and films.

INTRODUCTION

My father, Charles Eric Palmar (CEP), was Curator of Natural History in Kelvingrove Art Gallery and Museum, Glasgow from 1949 to 1984. He studied, photographed and filmed natural history subjects, particularly golden eagles, over many decades.

Over the past two years I have been working on a project to scan, archive and make publicly accessible many of his photographs. I have archived some of his photographs on my website (www.photoscot.co.uk) and a talk on the project *Behind the Naturalist's Lens* was given to the Glasgow Natural History Society in the spring of 2018, which is the basis of this contribution. My work has benefitted from the assistance of Ruth Olden, who initially helped with photo-editing, a job that involved identifying biological and geographical subjects, keywording, describing and renaming pictures. Later, before having to leave the project, Ruth applied successfully to the Blodwen Binns Bequest for funding that has supported part-time assistants – first Fiona Torrance and then Ami Kirkbright.

Norman Tait wrote an article in this journal about nature photographers, in which CEP featured (Tait, 2001), and a subsequent short note included some of his photographs (Palmar, 2014). Since, apart from obituaries, these are the only memorials in print to him and his involvement in natural history, I thought it appropriate to provide the following outline of CEP's life and major achievements.

CHARLES PALMAR'S EARLY YEARS IN ENGLAND, THE RAF AND HIS MOVE TO SCOTLAND

CEP was born in Royal Leamington Spa, and grew up in Brighton, where he went to Varndean School. The South Downs were therefore amongst his early stamping grounds. During his teens in the 1930s he became a very proficient naturalist. On various cycling trips round southern England, mainly in Sussex and Kent, but even to Devon and as far as the Forest of Dean, Monmouth and Ross on Wye, he wrote notes on the wildlife he encountered and on the photographs he took. Unfortunately, although there are 32 notebooks, no early photographs survive.

His notebooks were obviously valuable to him (Fig. 1). One early notebook from 1933 records butterflies he collected at the age of 12 at Newtimber in Sussex. "I arrived home with the following ones: Brimstone, Large Pearl Bordered Fritillary, Duke of Burgundy, Grizzled Skipper, Dingy Skipper, Orange Tip, Small Copper, Holly Blue, Wall Brown, Small White, yellow moth with black spots – 39 insects in all." What he did with them is not recorded. Nowadays they would be released, but in those days he probably kept and mounted them instead.

At the age of 17 on 31st August 1936, he records at Stanmer Park, Brighton a stone curlew (*Burhinus oedicnemus*), which he identified by its wailing call (which he had previously heard on Salisbury Plain), and he got his first look at a live stone curlew. Another bird flew up, and he noted "Had they bred here?" It is worth noting that stone curlews are now largely restricted to Salisbury Plain and the Breckland area of Norfolk.

During the Second World War, CEP was stationed as RAF ground crew at Manston in Kent, where bombs fell around him while he hid in a crater during the blitz, probably in 1940. The bombing must have had a severe effect on him - I imagine he had what would now be described as post-traumatic stress, as he was sent to Scotland to recover, spending several weeks in hospital in Larbert before being posted to Oban.

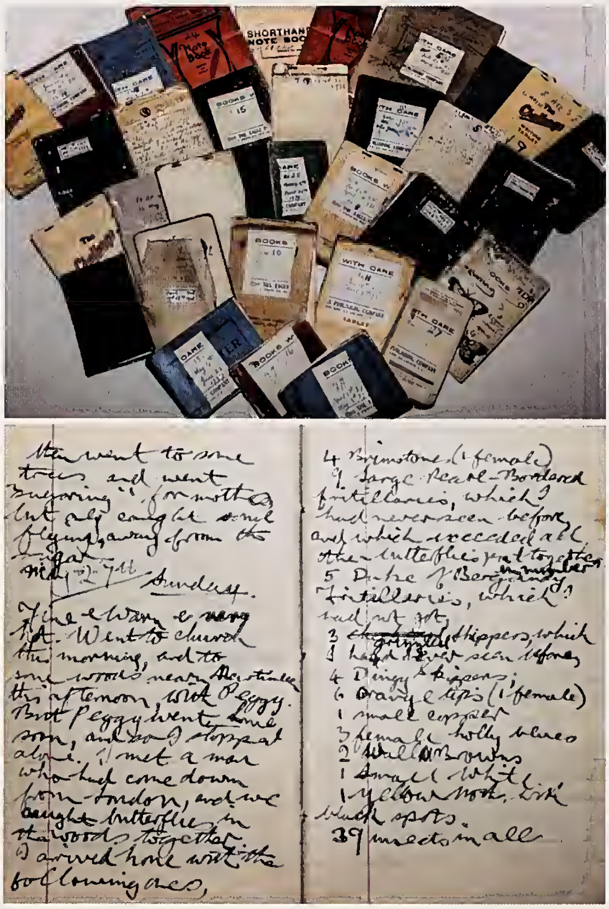

Fig. 1. Charles Palmar's notebooks. Top: a selection of his notebooks. Bottom: his notes for 27th May 1934. (Photos: D.C. Palmar)

EARLY YEARS IN SCOTLAND

After the war CEP came to Glasgow and found work as a medical photographer at Yorkhill Hospital. It was at this point that he went to a natural history meeting, and found that only he and my mother Molly had turned up. Romance must have blossomed, as they married in 1949 and went to live in a flat in Clarkston Road, Cathcart.

Molly graduated from the University of Glasgow with first class honours in Botany, and so she was able to help him with plant identification. Most of her exquisite plant drawings, along with her notes, now reside in the University of Glasgow library. In the 1950s, Molly was a demonstrator in botany in what is now called the Bower Building and helped in the production of his early films, e.g. *Carnivorous Plants*, which was made in 1952 and included sundew (*Drosera* spp.) and butterwort (*Pinguicula* spp.) After university, Molly became a biology teacher at the Park School, Glasgow.

In 1949 CEP was appointed Curator of Natural History in Kelvingrove Museum and Art Gallery, and in 1958 the family moved from Clarkston Road to University Avenue, quite near the museum. CEP had a darkroom in University Avenue, where he developed black-and-white films and prints (Fig. 2). He became involved in various natural history activities, some local, some further away. He met George Waterston, then Scottish Director of the Royal Society for the Protection of Birds (RSPB), at the Osprey Camp at Loeh Garten in 1965, and later Charles Millican sent him records of golden eagles on Mull, which he passed on to George Waterston at the Scottish Ornithologists' Club (SOC).

Fig. 2. Charles Palmar's photograph of a male capercaillie (*Tetrao urogallus*) displaying in the 1950s. (Photo: C.E. Palmar)

Amongst his many endeavours he was partially responsible for an agreement with the landowner to create a Scottish Wildlife Trust Reserve at Ardmore Point, near Helensburgh on the Firth of Clyde. Perhaps ahead of his time, he also took an interest in invasive species, a topic which takes centre stage these days. During the mid-20th century he was a member of the GNHS, then known to my parents as the "Andersonian Naturalists", and he became a member of the GNHS Council, latterly a Vice-President. He was also on the local committee of the Scottish Wildlife Trust and served on the Council and as Chairman of the Glasgow branch of the SOC, of which he was elected an honorary member in 1984.

It is for his work with golden eagles that CEP will be most remembered. This became a passion in his life. From 1947 onwards, he studied, photographed and filmed golden eagles, particularly in Argyll during the 1950s (Fig. 3). "There, his research on the eagle placed him in a small, confidential conclave of ornithologists, including the late Dr Leslie Brown, P.W. Sandeman, the late George Waterston and Dr Adam Watson, whose pooled records constituted the total assay of information on the status of Scottish eagles in the 1950s and 60s" (Boyd, 1986). The first eagle photographs I have come across are from 1947 and are of an eyrie in Galloway, which Chris Rollie of the RSPB was able to identify last year. Much of his research on golden eagles (and other

Fig. 3. Golden eagles (*Aquila chrysaetos*). Top: Charles Palmar's 1952 photograph of an eagle landing in Argyll. Bottom: golden eaglets, North Uist, 1969. (Photos: C.E. Palmar)

Fig. 4. Field holiday: hide at a buzzard's nest (*Buteo buteo*), near Cuan Ferry, Isle of Seil, Argyll, with the author's brothers, Colin and Michael, in 1965. (Photo: C.E. Palmar)

species) was conducted during many family field holidays on mainland Scotland, the Inner and Outer Hebrides and the Northern Isles (Fig. 4).

CEP's work on golden eagles and other wildlife resulted in the publication of many photographs and articles, which are listed in the Appendix.

KELVINGROVE MUSEUM

CEP had been appointed Curator of Natural History at Kelvingrove Museum in 1949, succeeding Dr Stuart Henderson, who had been promoted to Depute Director. CEP was the first Curator of Natural History in the museum with a specific knowledge of birds since the original curator, James Thomason in the 1870s. He soon had an influence on the displays, and completed some of the large habitat groups in the Natural History Court, which had been started in the late 1940s, and which were only removed in the early 1980s. He also continued the tradition of the plant table, which was much appreciated by the general public (Fig. 5). CEP initiated the "Bird Class" – an extra-mural class of the University of Glasgow, which ran for seven years from 1959 and included excursions to Loch Lomond and elsewhere. The classes could be attended by over 100 people and holding them in the museum meant that CEP could use examples from the collection to illustrate particular points (Fig. 6). He started to redisplay the Bird Gallery in 1955 and attempted to include examples of all resident (and many migratory) birds on the British list - making it ideal for teaching bird identification. It was completed in 1963. A notable addition to the museum collection for which he was responsible was a specimen of the extinct great auk (*Pinguinus impennis*) (Fig. 7). This, one of only 78 skins in existence, was negotiated as a long-term loan from a private owner and later bought by the museum for £30,000.

Fig. 5. Plant table at Kelvingrove Museum in the late 1970s. In attendance is Dick Prasher M.B.E. (extreme left) who helped to assemble the plant table from 1964 until 1980. (Photo: C.E. Palmar)

CEP's contribution over the years to education was considerable – this included his work in the Kelvingrove Museum, which must have touched thousands of people who visited the bird and animal galleries over decades, his publications, the "Bird Class", and his contribution to many natural history societies. He also gave broadcast talks and illustrated lectures and made a number of films on wildlife and other subjects (see Appendix).

Fig. 6. Charles Palmar delivering a Bird Class lecture in Kelvingrove Museum during the 1960s. (Photo: Glasgow Museums)

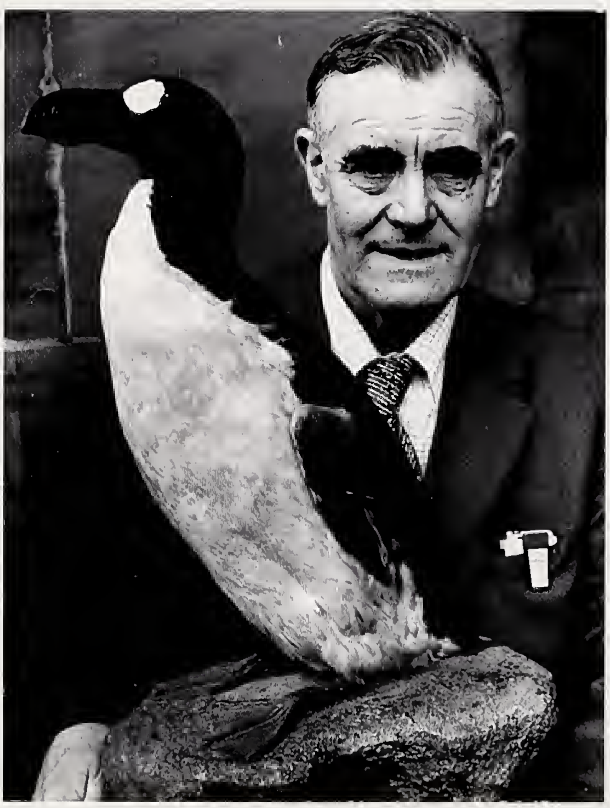

Fig. 7. Charles Palmar and his great auk (*Pinguinus impennis*), 1977. (Photo: Glasgow Museums)

RETIREMENT

CEP retired on 30th November 1984. He knew all of his staff and looked after them as individuals, and in the light of this, he was presented at a relatively light-hearted party in the Museum with a unique "Cheese roll collection". Each Museum department created an exhibit which commemorated the fact that he had a cheese roll for morning break in the Museum tearoom for many decades (Fig. 8). There was a special formal retirement dinner for him at Pollok House on 6th December of that year, which was attended mainly by senior colleagues and members of the Natural History Department.

Fig. 8. Stained glass window of a cheese roll, created for Charles Palmar's retirement party in Kelvingrove Museum, 1984. (Photo: D.C. Palmar)

As a retirement project, CEP had been planning to write a book about *Fifty Years of Natural History* (the title taken from a talk he gave to the GNHS). Unfortunately, shortly after he retired, he was taken ill with a brain tumour, and was unable to do much fieldwork, being restricted to printing some colour enlargements of a few of his photos, and the book never materialised. He died on 14th February 1986.

It is hoped that this article and the website archive, both part of the *Behind the Naturalist's Lens* project, will go some way to commemorating his contribution to Natural History in Scotland and beyond. Included in the archive of photos on the website www.photoscot.co.uk are a number of historical as well as natural history photographs.

ACKNOWLEDGEMENTS

I am grateful to both my parents for inspiring me to take up an interest in natural history, to Pat Palmar for assisting CEP in his natural history work, and to my wife Janet for assisting me in my project. I thank the Committee of the Blodwen Lloyd Binns Bequest fund of the GNHS for providing a grant, and Ruth Olden, Fiona Torrance, Ami Kirkbright, Alan Hill, Lizzy Cairns, Louise Smith and Douglas Lindsay for their help with various aspects of the project. Richard Sutcliffe,

John Murray and other people, too numerous to mention, contributed valuable reminiscences and anecdotes.

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Palmar, D.C. (2014). Murder in the eyrie: a behavioural study of a native species. 1950s Golden eagle *Aquila chrysaetos* photographs by Charles Eric Palmar. *The Glasgow Naturalist* 26(1), 50.

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APPENDIX

Charles Palmar's publications, broadcasts and films

Publications and broadcasts

1945. The raven. *Scottish Field*, February 1945.
1945. Birds in a Highland garden. *Scottish Field*, March 1945.
1945. The rookery in spring. *The Field*, April 1945.
1946. The whaups are back. *Scottish Field*, April 1946.
Late 1940s-early 1950s. Photos in various articles. *Birds of Britain* Vols. 1-5.
1950. Photo of swift in "An album of bird portraits". *RSPB Occasional Publications* No. 15.
1951-54. BBC Radio Home Service – 14 broadcasts.
1951. A Summer-Winter Diorama. *Museums Journal* 50, 263-266.
1951. Two photos of swans. *British Birds* 44, 384.
1951. Some reeent photographic studies of the golden eagle [with five others]. *British Birds* 44, 404.
1951-1956. Notes then Report on Birds of the Clyde area (with M.F.M. Meiklejohn). *Scottish Naturalist* in volumes 64, 65, 66.
1954. Scotland's golden eagles at home. *National Geographic* 105(2), 273-286.
1955. Photographs of golden eagles. In: Gordon, S.P. *The Golden Eagle, King of Birds*. Collins, London.
1955. My friend the eagle. *Scottish Field* July, 59-61.
1956. *The Capercailzie*. Forestry Commission Leaflet No. 37.
1962. Some photographic studies of the swift. *British Birds* 56, 19-22.
1962. *Titmice in Woodlands*. Forestry Commission Leaflet No. 46.
1962. *Animals of the Polar Regions*. Booklet. Glasgow Art Gallery and Museum.
1962. *Animals of Scotland Habitat Group*. Booklet. Glasgow Art Gallery and Museum.
1962. Arctic redpoll in Lewis. *Scottish Birds* 2(4), 251-252.
1963. Two photographs of capercaillie. *British Birds* 56(1), 19-22.
1965. *Woodpeckers in Woodlands*. Forestry Commission Leaflet No. 42.
1966. Front cover - golden eagle, and artiele – "Sea loch bird life". *Animals* 9(4).
1966. Photo of golden eagle and photo of great northern diver. *Ornithologische Mitteilungen* 18.
1968. *Blackgame*. Forestry Commission Forest Record No. 66.
1969. Photo of eight-week old golden eagle. *Birds of the World* 8(2).
1969. Photo of eider ducks. *Birds of the World* 10(2).
1969. Photo of female capercaillie. *Birds of the World* 11(2).
1970. *Titmice in Woodlands*. Forestry Commission Leaflet No. 46 (reprinted).
1973. *Titmice in Woodlands*. Forestry Commission Forest Record No. 89.
1976. *Capercaillie*. Forestry Commission Forest Record No. 109.
1976. Sowerby's whale and bottle-nosed whale. *The Glasgow Naturalist* 19(4), 337-338.
1979. Great auk. *Sunday Post*, 18th March.
1981. Dick Prasher, MBE, field botanist extraordinary. *The Glasgow Naturalist* 20(2), 175-176.
1984. Hunting eagles. *Amateur Photographer*, 1st March.
1985. *Natural History of Scotland*. Leaflet. Glasgow Art Gallery and Museum.

Posthumous publications

1988. Golden eagle photo. *Glasgow Herald*, accompanying letter to the editor from Greer Hart.
2013. Five photos and reference to articles. In: Ellis, D.H. *Enter the Realm of the Golden Eagle*. Hancock House, Surrey, British Columbia.
2018. Several hundred photos. In: Palmar, D.C. *Behind the Naturalist's Lens*. At: www.photoscot.co.uk

Films

Several of CEP's 16 mm cine films have been digitised, just in time before the colour had faded completely. In fact it was too late in one case – *Highland Eagle*, where the colour had faded to purple, and it had to be made into a black and white film. The films listed below were digitised and are now held by the Scottish Moving Image Archive at Hillington, Glasgow. The obituary by Boyd (1986) mentions a film entitled *Scenes from the Life of the Golden Eagle*, made in 1948 and said to be the first of its kind in colour. It is not included in the list, because I have no other evidence that such a film existed.

British Carnivorous Plants, 1952
Highland Heronry, 1961
Outer Hebrides – Human Activities, 1968
Highland Eagle a.k.a. King of Birds, 1970
Loch Lomond Nature Reserve, 1970
Seabirds in Scotland, 1974
Spring Flowers in a Scottish Wood, 1980

The Glasgow Naturalist (2019) Volume 27, Part 1, 45-48

First record of the non-native green palpworm *Marenzelleria viridis* (Annelida: Spionidae) in the Clyde Estuary

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ABSTRACT

The non-native polychaete worm *Marenzelleria viridis* (Verrill, 1873) was found for the first time in the upper Clyde Estuary in 2016. This represents the first occurrence of this alien species on the west coast of Scotland. It appears to be well established in low salinity waters at Govan Wharf where it dominated the biomass of riverbed infaunal invertebrates with densities of around 1,300 worms m^{-2}.

INTRODUCTION

The Spionidae is a large family of benthic tube-dwelling polychaete worms from marine or estuarine waters. They possess a pair of long cephalic feeding palps and a row of gills on either side of the body, commencing in the anterior region and continuing posteriorly to varying degrees in different species (Fauchald, 1977). The green palpworm *Marenzelleria viridis* (Verrill, 1873) is a spionid species native to the north-eastern coast of North America and is often abundant in low salinity estuarine waters (Maciolek, 1984). It was first found in European waters in 1982 in the upper Forth Estuary, Scotland (Elliott & Kingston, 1987) and subsequently in the Tay Estuary, Scotland in 1984 (Atkins *et al*., 1987). Since then it has spread throughout the North Sea and into the low salinity waters of the Baltic Sea (Gruszka, 1991; Essink & Kleef, 1993; Kube *et al*., 1996). However, investigations revealed major differences between the North Sea and Baltic populations indicating that two separate species may be present (Bastrop *et al*., 1995). There has also been some confusion regarding the possible occurrence in the North Sea of a sibling species from the Arctic, *Marenzelleria wireni* Augener, 1913, which, according to Maciolek (1984), is very similar to *M. viridis*, differing only in subtle respects.

The genus *Marenzelleria* was reviewed by Sikorski & Bick (2004) who established a new species *M. neglecta* for the Baltic material, although recognising that this too was an alien species that originally came from North America. They provided full descriptions of all four known *Marenzelleria* species, plus a provisional description (based on limited material) of another potential new species from North Carolina. They also provided a morphometric table of the diagnostic features for each of the species (for specimens at different sizes) and a simple dichotomous key for specimens more than 1 mm wide. They regarded *M. wireni* as restricted to Arctic waters, where it co-occurred with *M. arctia*, and considered most North Sea *Marenzelleria* material to be *M. viridis*, although both *M. viridis* and *M. neglecta* were recorded in the Elbe Estuary. Subsequently, Bick (2005) provided a full description of the new species from North Carolina and an updated dichotomous key for all five species.

In a further study of *Marenzelleria* material from the Baltic Sea, Bastrop & Blank (2006) used DNA markers to help distinguish species and found both *M. viridis* and *M. neglecta* were present in the western Baltic Sea, and also discovered that the arctic species, *M. arctia* had invaded the Gulf of Bothnia in the northern Baltic Sea. More recently, *M. neglecta* has invaded the Sea of Azov (Syomin *et al*., 2017). The arrival of various *Marenzelleria* species in low salinity waters throughout Europe, where they may become abundant, has spawned numerous studies of their invasion biology and ecological impact (e.g. McLusky *et al*., 1993; Kotta *et al*., 2003, 2006; Van Moorsel *et al*., 2010; Maximov, 2011; Michalek & Werner, 2012).

In British waters, records for *M. viridis* are summarised in the National Biodiversity Network (NBN) Atlas (National Biodiversity Network, 2019) and include records from the Beauly Firth, the Tay Estuary, the Forth Estuary (all Scotland), Berwick-upon-Tweed, the Tyne Estuary, the Humber Estuary, the Thames Estuary (all England) and in Northern Ireland from the Foyle Estuary and the Bann Estuary. Records of *M. wireni* in the Forth and Milford Haven in the NBN Atlas have probably been misidentified and are most likely to have been *M. viridis*. There are no records of *M. neglecta* in British waters, and *M. viridis* remains the only confirmed species in this region.

CLYDE ESTUARY SURVEY METHODS

In 2016 a small survey was undertaken in the upper Clyde Estuary, Scotland to provide some ecological data in relation to planned sewerage system works in the local vicinity. The survey was carried out on 3rd August 2016 and repeated on 6th September 2016 and 7th December 2016. Sampling of the river bed sediment was undertaken at three locations in Glasgow: upstream of Shieldhall Sewage Treatment Works (NS5420966394), Govan Wharf (NS5542966014), and upstream of Kelvin Confluence (NS5583065839) all of which have depths

of around 8 m. A single 0.1 m^2 Day Grab for biological assessment (and accompanying grab for particle size determination) were collected at the three sites. The biology grabs were washed on a 0.5 mm mesh sieve to remove fine sediments and the sieve residue transferred into a bucket, fixed with formaldehyde and returned to the Scottish Environment Protection Agency (SEPA) laboratory. The preserved biological samples were subsequently rinsed with water and contained fauna was picked out, identified and counted. The fauna was identified with the aid of standard keys (e.g. Hayward & Ryland, 2017). Subsequently the invertebrate specimens were preserved in methylated spirit and stored.

SURVEY FINDINGS

The macrofaunal invertebrates in the Clyde Estuary samples comprised mostly oligochaete and polychaete worms, with much smaller numbers of crustaceans, molluscs, and insect larvae (Table 1). The sediment near Shieldhall was muddy with leaf debris and supported a diverse and abundant fauna – but only in August. At Govan Wharf the sediment was muddy grit and had a diverse and abundant fauna on all three samplings. The sediment close to the Kelvin Confluence was undecomposed leaf litter and supported little or no invertebrate fauna.

The benthic fauna abundance was dominated by oligochaete worms (*Baltidrilus costatus, Tubificoides benedii, T. pseudogaster*, unidentified tubificid sp., *Nais* sp., *Paranais litoralis* and *Lumbricillus* sp.), which characterise low salinity estuarine sediments laden with riverine detritus.

The polyehaetes were generally much less numerous and included the estuarine ragworm *Hediste diversicolor*, and the spionids *Polydora cornuta* and *Streblospio shrubsolii*. However, the non-native green palpworm was found to be present at Govan Wharf, with relatively high numbers (142-156 per grab sample) on each sampling occasion, and with a single specimen also found at Shieldhall in August. *M. viridis* are relatively large worms, around 3-5 cm long, and were easily visible during the field sampling among the sediment residue on the sieve. They have a pale green colouration with distinct rows of red gills (Fig. 1). The ragworm *H. diversicolor* is similarly sized and coloured but lacks the red gills. The colouration in *M. viridis* is retained following fixation with formaldehyde but fades quickly once specimens are transferred to alcohol preservative. The characteristic feeding palps are invariably shed during sample proeessing and fixation (Fig. 1). The specific identity for the *M. viridis* specimens was confirmed morphologically using the key in Bick (2005). The Clyde specimens had over 60 segments with gills extending up to two-thirds of their body length, nuchal organs reaching the end of segment 2, and fewer than 15 segments between the appearance of the dorsal and ventral hooded hooks, all characteristic of *M. viridis*.

Only a few arthropods were found in the samples, including the brown shrimp *Crangon crangon*, amphipod shrimps of the genus *Gammarus*, and a chironomid midge larva. Molluscs were represented by one gastropod – the non-native Jenkin's spire snail (*Potamopyrgus antipodarum*), and a few juvenile Baltic tellin (*Limecola balthica*).

Fauna	**Shieldhall**			**Govan**			**Kelvin**		
	Aug.	**Sep.**	**Dec.**	**Aug.**	**Sep.**	**Dec.**	**Aug.**	**Sep.**	**Dec.**
Hediste diversicolor	4			2	2	3			
Marenzelleria viridis	1			142	142	156			
Polydora cornuta	1			4					
Streblospio shrubsolii	3			1	2				
Baltidrilus costatus	193	2		101	26	83	4		
Tubificoides benedii	15		1						
Tubificoides pseudogaster	51	1		63	4				
Tubificid sp.	146	4		275	194	83	1		
Nais sp.	74			14					
Paranais litoralis	454			90		2			
Lumbricillus sp.					2				
Gammarus sp.				7					
Crangon crangon	3			1					
Chironomid sp.				1					
Potamopyrgus antipodarum				1					
Limecola balthica				1	1				
Total abundance	**945**	**7**	**1**	**703**	**370**	**329**	**5**	**0**	**0**

Table 1. Upper Clyde Estuary Survey, 2016. Faunal abundance (number of individuals) per 0.1 m^2 grab.

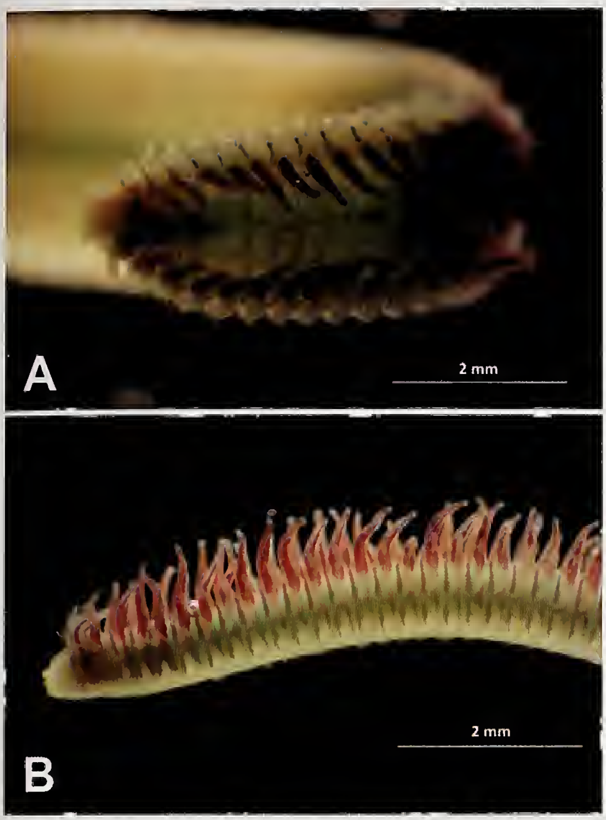

Fig. 1. Green palpworm (*Marenzelleria viridis*) from the upper Clyde Estuary. (A) Dorsal view of the anterior end, showing red gills and pale green body. Note that the feeding palps have been shed. (B) Lateral view of the anterior end of another specimen (also lacking the feeding palps). (Photos: M. O'Reilly)

Further sampling was undertaken at Govan Wharf on 15th November 2017 to find new specimens of *M. viridis* for photography and to re-assess its abundance. Two more 0.1 m^2 Day Grabs were collected and *M. viridis* was sorted live from the samples, which recovered 100 and 126 specimens respectively. The *M. viridis* were returned to the laboratory for fixing, counting and imaging. The imaging of *M. viridis* was undertaken on material freshly fixed with formaldehyde with the aid of a phototube on an Olympus SZX12 stereo microscope. The mean abundance of *M. viridis* for 2016 and 2017 sampling at Govan Wharf was 133 per grab giving an average density of 1,330 m^{-2}. Although oligochaetes are numerically more abundant at this location, they are much smaller than *M. viridis*, which dominated the faunal biomass. For example, the wet-blotted biomass for all macrofauna per grab in September and December 2016 was 1.81 and 6.63 g respectively, of which *M. viridis* comprised 75% and 96% by wet weight.

DISCUSSION

The upper Clyde Estuary has been monitored intensively on an annual basis from 1974 to 1995 by the Clyde River Purification Board including sites relatively close to Govan Wharf at the Broomielaw ("0 km"), the Kelvin confluence ("3.2 km"), and King George V Dock ("6.4 km") (see Henderson, 1984). From 1996 the monitoring was continued by SEPA, though less frequently with surveys every third year up until 2010. The fauna at these sites, where the salinity ranges from 0-17 psu, has always been dominated by small oligochaetes and fewer polychaetes but no *M. viridis* was ever recorded previously.

Although the 2016 survey fauna showed some depletion over the sampling period, the decline preceded the planned sewerage discharges (which occurred in October and November) and these changes were attributed to natural perturbations. The fauna found in 2016 was typical for these waters, except for the occurrence of *M. viridis*.

The appearance of *M. viridis* in the Clyde was unexpected but it seems to have become well established at Govan Wharf. *M. viridis* appears to have gradually spread around the estuaries of the British mainland but there are few records on the western seaboard and, until now, none in western Scotland. The nearest colonised sites are in the estuaries of the Foyle and Bann in Northern Ireland where it arrived in the late 1990s. It is believed that it is spread by transport of planktonic larvae in ballast waters of marine vessels so could well have spread from any other site around the U.K. or elsewhere depending on vessel movements. The Clyde population of *M. viridis* could in turn enable its spread to other areas although no studies of its reproduction, or dispersal of planktonic larvae, have been undertaken in this vicinity. It seems likely that *M. viridis* will maintain its presence in the Clyde Estuary as it has done in the Forth Estuary. It is just one of many non-native species which have become established in marine waters of the U.K. (Eno *et al.*, 1997). It is regarded as having low ecological impact in U.K. waters with respect to classification under the EU Water Framework Directive (UKTAG, 2015). However, its congener, *M. neglecta*, has had a significant ecological impact in the Baltic Sea and may possibly spread to U.K. waters (GB NNSS, 2011).

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SUPPLEMENT: ON THE WILD SIDE REVISITED: 200 YEARS OF WILDLIFE IN THE GLASGOW BOTANIC GARDENS

On the Wildside 2: the natural history of Glasgow Botanic Gardens revisited

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INTRODUCTION

In 1998 and 1999, *The Glasgow Naturalist* (*TGN*) published a set of papers under the heading "On the Wildside: the Natural History of the Glasgow Botanic Gardens", which reported the results of wildlife surveys carried out over the previous four years in the Glasgow Botanic Gardens. Table 1 lists the topics covered. As the year of the Botanic Gardens' bicentenary (2017) approached, Glasgow Natural History Society (GNHS) members felt that this could provide a good motivation for a new look at the biodiversity (in the wild state) of the Gardens. After discussions with staff of the Royal Society for the Protection of Birds' (RSPB) "Giving Nature a Home" project in Glasgow, it was decided that the new survey would be in two parts. First, a collation of new records made since the last surveys, a period of about 20 years. Second, the results of a BioBlitz in the Gardens, which would launch the RSPB's city wide "Wildfest 2017".

The concept of a BioBlitz was developed by Sam Droege and Dan Roddy in Washington DC in 1996, with the name actually coined by Susan Rudy (Wikipedia). A BioBlitz is intended to be an enjoyable and exciting event, usually over a period of one or two days (hence the "blitz" part of the name: something short and intense), bringing together non-university-based naturalists, university-based scientists, and volunteers in a race against time to survey all possible forms of life in an area of green space. It is intended to be a way of breaking down barriers to engagement with science, and raising awareness of the importance of biological recording. It provides an opportunity for members of the public to contribute to science, as part of the more general idea of "Citizen Science" and highlights the fact that you do not need to be an expert to make a contribution, though the experts can help.

The following papers provide the first set of results of both the long-term recording and the Blitz approach. Most of the articles both report on what new has been found and reflect on changes since the earlier surveys, where this information is available.

As was the case for the results in the 1990s, collating and writing up all the recent findings has taken longer than initially anticipated. Rather than wait until all the expected papers had been received, we decided to publish in two batches, six papers in this *TGN* issue, the remainder in the next one. We hope that this set of articles by Sarah-Jayne Forster, Richard Sutcliffe, Roy Watling and Richard Weddle will whet your appetites for the rest. It is worth noting here that the new set of papers does not give only an update on what came before. For example, the fungi of the gardens were not covered in the previous set of papers, and Roy Watling's article gives a valuable historical account of fungi recorded in the Gardens, both at the earlier Sandyford site and at Kelvinside.

In editing the 1998-99 account, Geoff Hancock indicated that the papers, when completed, would be assembled into a booklet. Unfortunately, this never happened, but the subsequent arrival of the internet may render such separate publication redundant. Past papers in *TGN* are now available online with open access at the Biodiversity Heritage Library (www.biodiversitylibrary.org/), and new papers appear on the GNHS website as they are published, and so are accessible to all.

Title	Author(s)
Introduction	G. Hancock (overall editor)
An historical introduction	E. Curtis
Plants growing in a wild state	P. Macpherson
Trees of Glasgow Botanic Gardens	R. Gray
Birds for all seasons	N. Grist & I. McCallum
Resident wildlife, seen and unseen: mammals	R. Sutcliffe
Underneath it all: the geology of the Botanic Gardens area	B. Skillen
Hidden wildlife: the resident population of invertebrates	G. Hancock

Table 1. Papers included in "On the Wildside", *The Glasgow Naturalist* 23(3,4).

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A "Wild Day Out!": finding wildlife in the Glasgow Botanic Gardens

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ABSTRACT
The Royal Society for the Protection of Birds (RSPB) held "Wild Day Out!" in the Glasgow Botanic Gardens (GBG) on 2nd September 2017. The objectives of the event were: knowing more about wildlife, recording wildlife, public engagement with nature, and partnerships. Included in a range of activities was a Bioblitz during which 71 new species reeords for the GBG were obtained. Of particular interest were the landhopper *Arcitalitrus dorrieni* (second record for Glasgow) and the bulrush wainscot moth (*Nonagria typhae*) (first adult record for Glasgow).

INTRODUCTION

For the launch event of RSPB's Glasgow WildFest (2017), and as a eontribution to the bicentenary of the GBG, RSPB held "Wild Day Out!" in the GBG on the 2nd September 2017. This event included a Bioblitz, a large-scale recording event aimed at taking a snapshot of all the species present at a site at a given time. This was the largest scale survey event for 20 years, when there was a similar snapshot taken in 1997 with a project called "Glasgow Botanic Gardens: On The Wildside" (Hancock, 1997, 1998).

Objectives of the Bioblitz

Knowing more about wildlife!

It is important to know the species that live in the GBG to see how management affects species and how these change over time. For the RSPB, this is espeeially important for urban priority species: bats (Microchiroptera), house sparrows (*Passer domesticus*), common swifts (*Apus apus*) and bumblebees (*Bombus* spp.). We can use this information to engage with people in the GBG about their local environment and talk about a range of different species. Over the last few years RSPB have been working with the GBG to think about the species that live there and engaging people with them, from doing mini-beast education session with schools to membership recruiters engaging with other visitors. As part of WildFest, RSPB Scotland created the "Beast of the Botanics" trail to engage children with the species that live there, and to encourage them to look for animals from amphibians to insects as part of their visit.

Records

It is vitally important to record species over time to detect trends so that action ean be taken to improve species diversity through conservation work. In the first *State of Nature Report* (Burns *et al.*, 2013), several wildlife organisations collaborated to present how British wildlife was faring. The *State of Nature Report* presented a very positive outlook on the importance of voluntary biological reeording, stating that the "contribution of voluntary and amateur recording to our understanding of U.K. wildlife populations and distributions is now world leading and its significance vitally important to national monitoring and conservation efforts".

Public engagement with nature

In Scotland there is an inereasingly urbanised population and a rising disconnection with nature. The major objective of RSPB's Giving Nature a Home project is to reconnect the people of Glasgow with nature, since exposure to natural spaces - everything from parks and open countryside to gardens and other greenspace - is beneficial for health (Muñoz, 2009). A Bioblitz is a great way to showcase the amount of wildlife that exists in green spaces in an exciting way that allows the general public to carry out scientific surveys and talk to a wide range of experts about wildlife and conservation. Doing such events in urban areas makes them more accessible to people that would not necessarily visit reserves or go out of their way to access nature. Such an event can therefore act as a first step in connecting disconnected groups. Removing transport costs also makes such events more accessible to those from disadvantaged backgrounds. The 2017 WildFest was the fourth in successive years and aimed to get more people engaged with wildlife on their doorstep. The festival attraeted 6,210 people directly through citizen science walks and talks, and green space events. Working with over 40 community groups, it delivered a month-long wildlife festival across the city generating increased opportunities for children to connect with nature and a better understanding of what wildlife is present in local green spaces.

Partnerships

The Glasgow Giving Nature a Home project started in April 2014 with the mission of connecting children, families and eommunity groups to create a city-wide wildlife garden, and celebrating nature within Glasgow. Since then the project has engaged with many individuals, families, schools and communities as well as partnering with a number of organisations to make the city better for nature. The project completes work year

round with schools through outreach work, Ambassador Schools and community conservation work.

"Wild Day Out!" activities

The day included a range of activities in addition to the Bioblitz:

- Children's activities such as bug-hunting, pond-dipping, face-painting, storytelling and gardening run by RSPB in the GBG, and by Children's Wood volunteers in North Kelvin meadow.
- The "Conservation Village" (Fig. 1) comprised stalls staffed by many conservation and wildlife organisations: RSPB, Butterfly Conservation, Marine Conservation Scotland, Glasgow City Council Countryside Rangers, The Conservation Volunteers, Saving Our Red Squirrels, Scottish Badgers, Grow Wild, Glasgow Natural History Society, Friends of Glasgow Botanic Gardens.
- "Species Identification Laboratory" (Fig. 2) inside the Kibble Palace, staffed by Glasgow Museums experts.
- Guided walks and workshops including: early morning birds, bird ringing, botanical recording, marine turtle conservation (Fig. 3), lichens, small mammals, moths, pollinators, the history of the River Kelvin, bugs, filmy ferns, and "worm-charming" - a competition between families to attract the most earthworms (Annelida) by stamping on the ground for 30 minutes (Fig. 4).

The number of people participating in events over the day totalled over 1,800 adults and 1,500 children.

Fig. 1. The "Conservation Village", with stalls staffed by conservation and wildlife organisations in the Glasgow Botanic Gardens. (Photo credit: G. Vaux)

Fig. 2. The "Species Identification Laboratory", staffed by Glasgow Museums experts in the Kibble Palace, Glasgow Botanic Gardens. (Photo credit: G. Vaux)

Fig. 3. A leatherback turtle (*Dermochelys coriacea*) in the Glasgow Botanic Gardens! (Photo credit: G. Vaux)

Fig. 4. Explaining "worm-charming", a competition between families to attract the most earthworms (Annelida) by stamping on the ground for 30 minutes. (Photo credit: G. Vaux)

Accuracy of information and verification during the Bioblitz

The methodologies followed best practice and standard techniques when and where possible. A range of pond-dipping and invertebrate nets, bat detectors, GPS survey equipment, field identification sheets and field guides were used.

Bats were recorded using hand-held acoustic bat detectors, which recorded the presence of bats using echo-sound, and specialists identified the sounds to species level.

Longworth small mammal traps were used to trap mammals. These were baited with appropriate food (mealworms, hamster food and fresh fruit) and bedding (hay). They were set up at dusk on the previous evening and checked again the following morning. Invertebrates were caught using sweep nets and jars, and specialist light traps were used for moths. Specimens were taken only where analysis after the event was necessary for verification of species. The recording sheets used to note species were thought to be clear and were successful at recording information.

RESULTS

From the "Wild Day Out!" Bioblitz many species known to be present were found in GBG such as a newt (*Lissotriton* sp.), a common frog (*Rana temporaria*), grey squirrels (*Sciurus carolinensis*) and a mouse (*Mus* sp.). More interestingly 71 new species records were obtained for the GBG (Table 1). These included some common but not previously recorded species such as the grey worm (*Aporrectodea caliginosa*), but also some more unusual species for the time of year, such as the whooper swan (*Cygnus cygnus*). The latter was a surprise, though we learnt later that there are two individuals known to be resident on the River Kelvin.

The most notable species of the day was the crustacean landhopper *Arcitalitrus dorrieni*, only the second record for Glasgow; the few other Scottish records seem to be exclusively from the islands or western coastal areas (R. Weddle, pers. comm.).

There were also some interesting moths found including the bulrush wainscot (*Nonagria typhae*), the first adult record from within Glasgow, though it has been seen in recent years in Bishopbriggs and the Motherwell area (R. Weddle, pers. comm.).

ACKNOWLEDGEMENTS

I thank: Gregory Vaux, RSPB, for permission to use the photographs; Roger Downie and Richard Weddle for comments on the manuscript; and Glasgow Museums Biological Records Centre and other expert volunteers for speeies verifications.

Group	N
Fern (Polypodiopsida)	3
Flowering plant (angiosperms)	41
Worm (Annelida)	2
Mollusc (Mollusca)	1
Crustacean (Crustacea)	1
Harvestman (Opiliones)	1
Insect – alderfly (Sialidae)	1
Insect – beetle (Coleoptera)	2
Insect – bee/wasps (Hymenoptera)	5
Insect – moth (Lepidoptera)	1
Insect - true bug (Hemiptera)	4
Insect - true fly (Diptera)	6
Spider (Araneae)	1
Springtail (Collembola)	1
Bird (Aves)	1

Table 1. New species records in the Glasgow Botanic Gardens, 2nd September 2017, noted during the "Wild Day Out!", by species group. N = number of new species.

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The Glasgow Naturalist (2019) Volume 27, Part 1, 53-56

The moths (Lepidoptera) of Glasgow Botanic Gardens

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ABSTRACT
The moths that have been recorded in the Glasgow Botanic Gardens, Scotland over the years are reviewed and assessed in the context of the City of Glasgow, the vice-county of Lanarkshire (VC77), and the U.K. in general. The additions to the list since the last review in 1999 are highlighted. Some rare and endangered species are reported, though the comparatively low frequency of sightings of several normally common species suggests that the site is generally under-recorded. The same is true of Glasgow and Lanarkshire in general.

INTRODUCTION
There are few records of moths in the Glasgow Botanic Gardens (GBG) prior to 1980-1999 when Dr Robin Knill-Jones did some moth-trapping there. Full details of the catches are not available, though a few were included in insect lists published by Iain Christie and Geoff Hancock in *The Glasgow Naturalist* at the time. Though many of these give the location explicitly as "Glasgow Botanic Gardens", there are others from "Glasgow, West End" some of which could also be from GBG. Subsequently, Graham Irving did some trapping in 2002, and there are further records from *Bat & Moth Night* events in August 2006-2009. However, most of the information presented here is derived from trapping done by the author between August 2009 and September 2018, approximately monthly during the warmer months. There are also records of moths over the years that have been found by other recorders and other methods such as field observations of day-flying moths or leaf-mines.

In Hancock's *Hidden Wildlife* account forming part of the original *On the Wildside* survey, only 11 moth species are listed, four of which are attributed to Knill-Jones (Hancock, 1999). The present account amplifies the information on some of these, and adds a considerable number of species to the list.

A list of all species that have been recorded in GBG (including the Kelvin and North Kelvin slopes) can be found at www.gnhs.org.uk/biodiversity/GBG_splist.pdf together with the years of the earliest and latest records and the total number of records of each moth (this is not the same as the total number of individual moths found, as any one record could comprise many individuals of that species).

At the end of 2018 the species list included 201 distinct moth species; this may be compared with the 859 moths which had been recorded in Glasgow as a whole at the same date. In this account I shall comment on just a few of those 201 species, which seem to be significant in one way or another. More detail on any of the records can be obtained from Glasgow Museums Biological Record Centre, and Scottish distribution maps of the various moths can be found at www.eastscotland-butterflies.org.uk/mothflighttimes.html

In the 2017 *Bioblitz* (including the *Bat & Moth Night*) 15 species of moth were recorded; two of these (rosy rustic and bulrush wainscot) are highlighted in the following sections.

U.K. BAP SPECIES IN GBG
Many moths are "species of conservation concern" on account of a marked decline in their numbers in recent years, and are listed as U.K. Biodiversity Action Plan (BAP) species. These species are also included in the Scottish Biodiversity List for the same reasons, even though it seems that, in many cases, species that are in decline in the U.K. generally may be still relatively abundant in Scotland or parts of Scotland.

In the following notes percentage declines over "the last 35 years" are taken from DEFRA (2016) and declines over "the last 40 years" are from Butterfly Conservation (2013); the declines are derived mainly from counts of moths from Rothamsted traps across the U.K. over the period starting 1968. In most cases the exact cause of the decline is unknown, but possibilities – or contributory factors - include agricultural intensification, habitat fragmentation, inappropriate management such as "tidying", use of pesticides and fertilisers, light-pollution, and climate change. See Butterfly Conservation (2013) for further discussion of these factors.

In the following notes, names and dates of observations refer to records held in Glasgow Museums Biological Record Centre database (and the database of the National Moth Recording Scheme) unless otherwise referenced. It should be noted that all cited numbers of "Glasgow records" include numbers of records from GBG. The taxonomic nomenclature is based on Agassiz *et al.* (2013) with published updates added in 2017 by Les Hill (National Moth Recording Scheme).

Hepialidae

Ghost moth (*Hepialus humuli*)

62% decline over the last 40 years; common in Scotland; four GBG records, 27 Glasgow records. Larvae in roots of grasses and other herbs including nettles (*Urtica* spp.).

Geometridae

Small phoenix (*Ecliptopera silaceata*)

77% decline over the last 35 years; common in U.K. generally; 79 Glasgow records, seven in GBG (2002-2016). Larvae feed on various species of willowherb (*Chamaenerion* spp.).

Latticed heath (*Chiasmia clathrata*)

85% decline over the last 40 years; common in the south of Scotland, absent or stray in the north, but range expanding; one GBG record, 103 Glasgow records. Larvae feed on clovers (*Trifolium* spp.) and lucerne (*Medicago sativa*).

Noctuidae

Mouse moth (*Amphipyra tragopoginis*)

85% decline over the last 40 years; common in the east of Scotland, scarcer in the west; numbers have declined; four GBG records, 79 Glasgow records. Larvae feed on a wide range of herbaceous plants including sallow (*Salix* spp.) and hawthorn (*Crataegus* spp.).

Mottled rustic (*Caradrina morpheus*)

84% decline over the last 40 years; common in England and in south and east Scotland; one GBG record (R.B. Weddle (RBW) in 2017), 16 Glasgow records. Larvae feed on a wide range of herbaceous plants including nettle and docks (*Rumex* spp.).

Rustic (*Hoplodrina blanda*)

78% decline over the last 40 years; widespread in Scotland on low ground and coast; 29 Glasgow records; only one in GBG (RBW in 2016, confirmed by R. Leverton), though there is also a "West End" record (R. Knill-Jones in 1981) which may possibly be from GBG. As this species is easily confused with the uncertain (*Hoplodrina octogenaria*) some of these records may be better described as "rustic/uncertain agg.", though several are confirmed (there are three further Glasgow records confirmed as uncertain, all from identified locations in the north west). Larvae feed on a wide range of herbaceous plants including chickweeds, docks and plantains (Plantaginaceae). Dalglish (1901) described its abundance in the Clyde area as "local and rare" (listed as *Caradrina taraxaci*).

Rosy rustic (*Hydraecia micacea*)

86% decline over the last 40 years; common in Scotland; 25 Glasgow records, including five from GBG (two of which were in separate traps run for the 2017 *Bat & Moth Night*). Larvae feed on a wide range of herbaceous plants including docks and plantains.

Ear moth (*Amphipoea oculea*)

71% decline over the last 35 years; common in U.K. generally; recorded once at GBG (R. Sutcliffe in 2004), also a second record (R. Sutcliffe in 2004) as *A. oculea* agg. only one other record of *oculea* agg. in Glasgow (*oculea* is the commonest species in this group). Larvae feed on stems and roots of grasses (as do other members of the *Amphipoea* group).

Dusky brocade (*Apamea remissa*)

76% decline over the last 35 years; common in Scotland; 34 Glasgow records, two in GBG. Larvae feed on grasses such as reed canary-grass (*Phalaris arundinacea*) and common couch (*Elymus repens*).

Centre-barred sallow (*Atethmia centrago*)

74% decline over the last 40 years; occasional though widespread in Scotland, particularly in the southern half; woodland and hedgerow; two records from GBG, in 2001 and 2006 (both R. Sutcliffe); there are also more recent records in the West End of Glasgow (six Glasgow records in all), and more recently still in South Lanarkshire and East Dunbartonshire. Larvae feed on ash. Regarded as a good indicator of what is happening in the wider environment (DEFRA, 2016).

Dark brocade (*Mniotype adusta*)

78% decline over the last 35 years, most markedly in the southern half of England; common and widely distributed in Scotland; one GBG record (RBW in 2014), five Glasgow records. Larvae feed on various grasses and a variety of low plants.

Garden dart (*Euxoa nigricans*)

98% decline over the last 40 years; widespread but scarce in south-west and east Scotland; apparently declining; two GBG records, four Glasgow records. Dalglish (1901) described its incidence in the Clyde area as "not common; [occurring] at ragwort and sugar", which suggests that the adults are most often found by torchlight while they are nectaring; however, through the 1980s John Morgan found it regularly in small numbers in the Penilee area of Paisley, and so it appears to have been locally common there. Larvae feed on clovers, docks, and plantains.

Small square-spot (*Diarsia rubi*)

87% decline over the last 40 years; common in U.K. generally; 14 records in Glasgow, three in GBG. Larvae feed on a wide range of herbaceous plants including dandelion (*Taraxacum* spp.), docks and foxglove (*Digitalis purpurea*), and so might be expected to be recorded more frequently.

GBG MOTHS UNRECORDED ELSEWHERE IN GLASGOW

Nepticulidae

Ectoedemia decentella

Recorded once (N. Gregory in 2008); common in England, though so far found only in Lanarkshire and Fife in Scotland. Larvae feed on sycamore "keys" (*Acer pseudoplatanus*), so very likely to be under-recorded.

Gracillariidae

Povolnya leucapennella

Recorded once (N. Gregory *et al.* in 2009); local across U.K. Larvae feed inside "cones" rolled in the leaves of oaks (*Quercus* spp).

Gelechiidae
Aproaerema anthyllidella
Recorded once (RK-J in 1982); common in England, more local in Scotland. Larvae feed in blotch-mines in kidney vetch (*Anthyllis vulneraria*) and other low herbs that grow in a similar habitat.

Saturniidae
Atlas moth (*Attacus atlas*)
Introduced: a large moth of forests of south-east Asia; the GBG specimen was introduced as a caterpillar from India and emerged as an adult in May 1916 (McLachlan, 1919).

Geometridae
Lesser treble-bar (*Aplocera efformata)*
Recorded once (by R. Sutcliffe in 2004). In Scotland commonest in West Lothian and Falkirk (on bings and in quarries) but regularly found in recent years in Motherwell (D. Abraham in 2013-17). Larvae feed on St. John's-wort (*Hypericum perforatum*).

Sphingidae
Small elephant hawk-moth (*Deilephila porcellus*)
Recorded once (G. Irving, 2002); local across U.K., with an eastern bias in Scotland. Larvae feed on bedstraws, also on rosebay willowherb (*Chamaenerion angustifolium*) and purple loosestrife (*Lythrum salicaria*).

NOTES ON OTHER GBG MOTHS
Since Hancock (1999) there have been no further records in GBG of *Adela reaumurella,* spindle ermine (*Yponomeuta cagnagella*), rhomboid tortrix (*Acleris rhombana*), or July highflier (*Hydriomena furcata*). However, there have been three records of *Agriphila straminella,* seven of *Agriphila tristella,* eight of brimstone (*Opisthograptis luteolata*), 32 of large yellow underwing (*Noctua pronuba*), and three of silver Y (*Autographa gamma*).

Of these, the micro-moths are likely to be the less recorded (which will apply to the GBG species list in general), as they tended to be ignored until recent years when good identification guides became available; also they become worn quite quickly and therefore more difficult to identify. The large yellow underwing can occur in large numbers in the trap: on occasions there have been 100 or more. The silver Y is an immigrant, which arrives annually in varying numbers; the numbers found in the GBG trap probably depend on whether it is operating at a time when the moths are on the move.

Gracillariidae
Azalea leaf-miner (*Caloptilia azaleella*)
Native to east Asia; an accidental introduction to U.K., on azalea plants (*Rhododendron* spp.). Hancock (1999) states that Knill-Jones' record of blister-mines attributed to this species at GBG may be the only known occurrence in Scotland; unfortunately no date is cited. Knill-Jones also recorded this species at Garscube (Glasgow/East Dunbartonshire) in 1983. Its presence in GBG was confirmed in 2016 by the presence of an adult in the moth trap, and there are further records of adults from the urban area adjacent to Linn Park in the same year (by G. Williamson). An adult was also recorded in 2015 in Dumbarton (by A. Kerr). The species is probably very under-recorded in this area generally.

Yponomeutidae
Bird-cherry ermine (*Yponomeuta evonymella*)
A common species in the area, the caterpillars of this small but attractive moth are gregarious and notable for spinning protective webs over large parts of bird-cherries (*Prunus padus*), sometimes completely defoliating them – as happened annually on a tree near the Flint Mill bridge on the Kelvin Walkway downstream of GBG (the tree was removed in recent years). The first record in GBG was in 1981 (by R. Knill-Jones). There are no subsequent records until August 2015, and it has appeared in small numbers in the trap in August of each subsequent year. There are 81 records from Glasgow.

Tortricidae
Light brown apple moth (*Epiphyas postvittana*)
A native of Australia first recorded in the U.K. in Cornwall in 1936, and gradually moving through the U.K. (perhaps with the aid of horticultural suppliers and garden centres). Classified as invasive in U.K., though here it is not an orchard pest, seeming to prefer a miscellany of garden trees, shrubs, and herbaceous plants. Found fairly regularly in the GBG trap, normally in small numbers, though there were 18 individuals on one date in May 2017; however, there is no evidence that it is a significant pest there. There is only one record in the Clyde area of Scotland outwith the Glasgow City boundary, and that was in Bishopbriggs near the Forth and Clyde canal (A. Winthrop in 2015).

Geometridae
Gem (*Nycterosea obstipata*)
Migrant; occasional scattered records mainly in the south of Scotland; one record in GBG, 2017 (R.B. Weddle, det. R. Leverton); the only other Glasgow record is in Kelvingrove Park at the end of the 19th century (by G.W. Ord, labelled *Melanippe fluviata*); also in Kilmacolm (by N. Gregory in 2007).

Noctuidae
Bulrush wainscot (*Nonagria typhae*)
Scarce in the west of Scotland; the GBG specimen is the first adult found in Glasgow, and was discovered by a participant in the 2017 *Bat & Moth Night.* A larva was found in a *Typha* stem at Possil Marsh by R.A. Crowson in 1988; Crowson had previously found larvae at Dalzell Estate in 1983, and there are recent records of adults from Motherwell, Bishopbriggs and Lochwinnoch.

CONCLUSIONS
The aim of the above remarks is to put some of the GBG moth records in the context of the records in Glasgow

and the wider area as a whole. It has to be said, though, that there are not, and in the last 100 years have never been, many recorders moth-trapping on a regular basis. Currently there are only about seven locations in Glasgow where moth traps are being run more or less regularly, three of those are in the West End, and all are in predominantly urban environments. Moth records from the other parts of Glasgow in recent years have come from one-off trapping events, and *ad hoc* records of day-flying moths or caterpillars. It is therefore clear that GBG and Glasgow as a whole are very under-recorded (the same is also true of most other groups of insects with the possible exception of butterflies).

There is of course a relatively restricted range of habitats in GBG compared with the city as a whole. However, there is undoubtedly much more scope for additions to the GBG moth list for a number of reasons: the moth trap is situated, for seeurity reasons, among illuminated glasshouses, which is not ideal; not all moths come to the mercury-vapour lamps used in the trap; and GBG contain plant species which do not occur (or are uncommon) elsewhere in Glasgow. So it is likely that further species could be added by trapping in other locations within GBG – though on the few occasions this has been tried by the author, there were no previously unrecorded species – or by other methods such as searching for caterpillars, leaf-mines and other larval signs, or by techniques sueh as "sugaring" where moths are attracted to sweet aromatic preparations (see Butterfly Conservation https://butterfly-conservation.org/ for details). The same methods could also be applied in other areas of Glasgow where no systematic moth recording has been done.

ACKNOWLEDGEMENTS
I am grateful to Ewen Donaldson and his staff at Glasgow Botanic Gardens for putting out the trap when requested; to the following recorders: Neil Gregory, Geoff Hancoek, Graham Irving, Robin Knill-Jones, Chris Pantrey, and Riehard Sutcliffe; to Glasgow Museums Biological Record Centre for contextual records from other vice-counties (which includes those parts of Glasgow in Renfrewshire (VC76) and Dunbartonshire (VC99)); and to Richard Sutcliffe again for helpful comments on this note.

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The Glasgow Naturalist (2019) Volume 27, Part 1, 57-67

The tale of the fungi of two gardens: non-lichenised fungi of the Botanic Gardens in Glasgow

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ABSTRACT
A brief history of the early days of mycology in Scotland is given to act as a starting point from which to view the fungal records made in the gardens at Sandyford and Kelvinside. The former was vacated in 1842 and the garden transferred to the present site at Kelvinside under the authority of the Glasgow City Council. The role of J.F. Klotzsch in generating the earliest records is emphasised and the compilation of fungal records, mainly of macrofungi, until the present day is discussed. A short account of the microfungi is given. A complete list of the fungi recorded from the two gardens is provided.

INTRODUCTION - SETTING THE SCENE
Thomas Hopkirk was a founding father of the Royal Botanic Institution of Glasgow, which was assigned land for a Botanic Garden at Sandyford, then on the western outskirts of the city. He is best known in mycological circles for the inclusion of an account of the fungi of Clydesdale in his *Flora Glottiana* "that it may prove useful to the Botanical student" (Hopkirk, 1813). It includes 104 fungal names and is the first such account of a local fungal flora to appear in Britain. Before Hopkirk one Clydesdale botanist named a handful of fungi in his *History of Rutherglen and East Kilbride* (Ure, 1792), including the scarlet cup "*Sarcoscypha coccinea*" (although the specific taxon is unknown, as a former variety – var. *jurana* – is now considered to be a distinct species).

Hopkirk was a graduate of the University of Glasgow, becoming an important Glasgow businessman and a friend of William Jackson Hooker when he came to Glasgow to take up the position of Professor of Botany. Hooker had given up microscopic work by then, because, since James Sowerby had died before the completion of his *British Flora*, it had fallen on Hooker to complete the task. He soon concentrated on the flowering plants, admitting that he knew very little about fungi. He relied heavily on Lightfoot (1777), who paid unusual attention to the fungi (Ramsbottom, 1963). Hooker, although relying partly on Hopkirk as well as Dickson (1785-1801), opted to use *A Botanical Arrangement of British Plants* (Withering, 1792) for the major part of his work, but decided to base the section on fungi on Persoon (1797). He was assisted in this endeavour by a young student from Germany, J.F. Klotzsch. Hooker had collected a few specimens, some of which are in the herbarium of the Royal Botanic Gardens, Edinburgh, but Klotzsch set about documenting these as well as gathering fungi from around Glasgow for inclusion in Hooker's herbarium. He also travelled further afield, e.g. to Castle Semple, Renfrewshire, and to the Highlands where he accompanied Hooker. Watling (2016) listed the localities where Klotzsch collected whilst in Scotland. Klotzsch stayed in Glasgow for two years, accumulated a vast collection for Hooker, and introduced the idea of slicing specimens before they were dried for preservation. Following the tradition of the time, these specimens, along with his library and manuscripts, followed Hooker to the Kew Botanical Gardens when he went there as Director in 1841 (Bower, 1901). The Kew fungal material became the basis of the now internationally recognized fungarium at Kew, but some material apparently made its way to at least two places in Scotland, as documented by Watling (2014, 2016). Sadly no specimens collected by Hopkirk have been located. Perhaps the Edinburgh material of Klotzsch was part of an exchange with the Edinburgh-based cryptogamist, R.K. Greville, also a friend of Hooker, although there are no details of a gift or exchange in the documents at the Edinburgh's Royal Botanic Gardens. In the *Mycologia Scotica* of Stevenson (1879) there are frequent references to Klotzsch when records assigned to Hooker are mentioned. A collection now in the Glasgow Museums Resource Centre contains Klotzsch material gifted by a Capt. Fleming and includes several specimens from Inveraray, Argyll and Bute, and material from Garscube, Glasgow. A collection of *Sphaeria (Depazea) unedonicola* Klotzsch is referred to by Grove (1935-37), although it apparently lacks Klotzsch's manuscript name. This collection has been discussed by Watling (2014). Hooker's floristic work, including fungi, was completed by M.J. Berkeley and finally appeared as part of both *The English Flora of Sir James Edward Smith* Vol. 5 and *Dr. Hooker's British Flora* Vol. 2 (Hooker, 1836). Sadly, after Klotzsch there was a mycological void for about forty years until R.H. Paterson's contributions (see below) and by this time the garden had been moved from Sandyford to Kelvinside (Bower, 1901).

There are records of fungi collected by R.H. Paterson and members of The Andersonian Naturalists of

Glasgow from Bowling, Helensburgh, Ben Lomond, Ben Vorlich, Luss, Toward and Innellan, as well as Glasgow, including the Kelvinside Botanic Gardens. Paterson and others prepared a list of fungi for the 1876 British Association Handbook for its Glasgow meeting (Paterson, 1876). The handbook contains 34 pages of fungal names in double eolumns with no information except district. In his aeeount of Scottish mycology Ramsbottom (1963) considers Paterson's appendix to be worthless, although those fungi found in the Sandyford garden are indicated. Nineteen fungi are speeifieally referred to this garden, including seven microfungi, two rusts, three truffles, two fairy-clubs and four agarics. He included some of Klotzsch's records. Paterson also edited later editions of *The Clydesdale Flora* (Hennedy, 1878), but in all editions, as in similar floras of the region such as Lee's (1933), the text does not mention fungi. In 1890 T. King is noted as having found chanterelles (*Cantharellus cibarius*) in the Kelvinside Botanic Gardens, but he is best known for encouraging local cryptogamists and assisting their curation of the Hennedy collections (Stewart, 1901). Paterson corresponded with Greville, being mentioned in *A Scottish Cryptogamic Flora* (Greville, 1823-28) as was J. Rennie of Glasgow. In Edinburgh there is material collected by R.H. Paterson in M.J. Cooke's herbarium, for instance the small discomycete *Hyalinia rubella*.

At the turn of the century a list of gasteromycetes collated by R.B. Johnstone was incorporated into *The Fauna, Flora and Geology of Clyde Area* (Stewart, 1901). Johnstone was treasurer of the Cryptogamic Society of Scotland and in his time added 100 species to the Scottish fungal list, many from the Glasgow area. He was variously Secretary (1891-1913) and President (1917-1918) of The Andersonian Naturalists of Glasgow.

Toward the end of the first decade of the 20th century Daniel Alexander Boyd sat on a subcommittee that prepared a report on the fungi of Clydesdale district for another Glasgow British Association meeting (Anon., 1928). This account added seven new records and had references to the classic collectors of the time such as the Rev. J. Stevenson and Rev. J. Keith. Boyd also wrote an article on fungi for a third British Association Meeting (Boyd, 1928), where he developed ideas on the occurrence of fungi in relation to the physical features of the Clyde area. Boyd was qualified as a Writer to the Signet but never practised and spent his time studying archaeology and natural history, finally taking a particular interest in "stem and leaf fungi" (coelomycetes) and other microscopic entities. He became noted for his many records new to the British Isles and his records and experience were acknowledged in what was until very recently the standard work on these organisms (Grove, 1935-1937). Some of these specimens would have been transferred when the British Museum's collection of fungi went to Kew. Sadly, although some of his speeimens are said to have been located in the Kew fungarium, few have survived to voucher the records. A few specimens have been found in the herbaria of Strathclyde and Glasgow Universities (Watling, 1986), which are now ineorporated into the Glasgow Museums Resource Centre as the Glasgow University Herbaria. A few others have now been loeated in the Edinburgh Herbarium. Boyd published many of his finds in *The Scottish Naturalist*, and these records appeared as appendices to the supplements in Stevenson (1879). R.B. Johnstone (1931) recorded that this was the last contribution made by Boyd, as he died in 1928.

R.H. Johnstone (son of R.B. Johnstone, mentioned above) was a member of the British Mycological Society and selected collecting sites for the 1959 foray based in Glasgow and for the European Mycological Congress held in Glasgow in 1963. The identities of specimens collected on those oecasions were confirmed by a range of British myeologists. R.H. Johnstone published notes on Clydesdale fungi in *The Glasgow Naturalist* (Johnstone, 1946). Specimens belonging to R.H. Johnstone, formally housed at the University of Glasgow, and material from the University of Strathclyde are now loeated in the Glasgow Museums Resource Centre.

The above historical account provides a background against which the fungi recorded from the Sandyford and Kelvinside gardens can be discussed. It should be mentioned that there is no information on the fungi of the Physic Garden owned by the University of Glasgow, which existed prior to 1817 at the High Street site (Boney, 1986) and whieh was the forerunner of the Sandyford garden.

THE LARGER FUNGI: SANDYFORD

All material indicated by Klotzsch to be from the "Botanic Garden" would have come from the Sandyford site and not the present day garden at Kelvinside. Thus there is some discrepancy in the records held by the British Mycological Society, which mix those from the two gardens. Another problem is that when old names were updated to accord with current usage generally no reference was made to the actual specimens, thus providing a potential souree of error.

Many of Klotzsch's collections are unlocalised and fungi are described as being "common" or "widespread" with or without aeeompanying data. Many of these speeimens could have originated from the Sandyford garden as the taxa noted would be expected to oceur in the grounds of any wooded plot. This also applies to the listings in Paterson (1876), since the designation "common" might include Botanic Garden collections. On the other hand, it is well-documented that whilst in Scotland Klotzsch described several species new to science based on collections from the Sandyford garden. One species is named after Klotzsch's mentor, W.J. Hooker - *Agaricus hookeri*, placed in the classic texts under *Lepiota*, although erroneously in *Hebeloma* by Paterson (1876). It is now known to be the same as *Melanophyllum haematospermum*, a small, insignificant agarie which generally favours relatively base-rich soils in shrubberies and at wood-margins. Another species

was named after Hooker's wife, who apparently found it in the garden – *Agaricus mariae*, a species whieh was soon transferred to *Lepiota* but is now known as *Echinoderma asperum*. It was listed by Paterson (1876). Perhaps one of the most spectacular fungi Klotzsch described was from the glass-houses at the Sandyford garden - the false truffle *Hymenangium album*, a "reduced" secotiaceous member of the Cortinariales. Nomenclatorially it has had a chequered career, for, although always aceepted as a distinct species, it has been moved from one genus to another and even the specifie name has been changed (viz. *Hymenogaster klotzschi*), due to a misinterpretation by the "father of British mycology" - the Very Rev. M.J. Berkeley. It has finally been returned to Klotzsch's original genus. Klotzsch's false truffle is apparently native to the eucalypt forests of Australia and was obviously brought in on the roots of a plant introduction. It has been found in botanic gardens in Edinburgh, Kew and on the continent, always associated with eucalypts. There are two collections in Kew, which are both from the Sandyford garden, one being the isotype.

Another new species was published by Berkeley with reference to Klotzsch, viz. *Psilocybe areolata*, whieh represents a form of the weeping widow (*Lacrymaria lacrymabunda*) possessing a cracked pileus. The basidiospores are distinctive, so allowing placement with certainty in *Lacrymaria*, but the present author has never, in many years of collecting, found the pileus of *L. lacrymabunda* cracking. It is possible that the fibrillose velar tissue might have separated on drying to reveal the cuticle below, which, in common with other psathyrelloid agarics, is a cellular hymeniderm; in some species this becomes fissured. This fungus is characterised by soot black gills, which produce strongly ornamented basidiospores with wart like prominences. Its common name - weeping widow - comes from the fact that, when growing actively, the gills produce glistening droplets of a watery fluid which eontrast with the dark gills, recalling a widow's grief and clothing. Klotzsch did not appreciate the variability of this fungus, since he introduced "*Agaricus tabularis*" for a eollection of the very same taxon, which was also collected in the Sandyford garden. However, another species had previously been named "*Agaricus tabularis*" (which is now *Cortinarius tabularis*). The small size exhibited by Klotzsch's colleetion may show he was right in recognising a separate entity, since it could represent *L. glareosa*, a very close relative of the weeping widow, which is difficult to separate without field data. It grows in disturbed gravelly areas, on construction sites, and at the edges of glacial activity, the last probably being the natural habitat. A surprise amongst the Klotzsch material is *Hebeloma radicosum*, as it has a rather restricted distribution in Scotland. It was eollected in Sandyford in August 1830 and is a particularly interesting record as the fungus has been shown to be intimately connected with the burrows of moles and rodents.

THE LARGER FUNGI: KELVINSIDE

Paterson (1876) listed a few species from what must have been the garden at Kelvinside, viz. *Agaricus* (now *Leucocoprinus*) *cepistipes*, commonly found near habitation on leafy litter, *Tricholoma* (now *Leucoagaricus*) *meleagris*, a species that grows on warmed wood shavings and leaf mould, and *Agaricus* (now *Hebeloma*) *crustuliniforme*, a species also recorded by William Stewart in 1897, along with *Lepista* (as *Tricholoma) sordida*. The last might be expected to occur with birch (*Betula* spp.) in the Kelvinside garden. *L. sordida* is a fungus of shrubberies, so the presence of this agaric is not surprising. A collection of the closely related field blewit (*L. saeva*) is very interesting, as this species is a truly grassland agaric; it was discovered in the Kelvinside garden by a member of the general public. Paterson also included in his listings *Lepiota acutesquamosa*, which must refer to Klotzsch's *Agaricus mariae* (now *Echinoderma asperum*), and *L. clypeolaria*, which has been discussed extensively (Watling, 2014). Other species of fungi mentioned by Paterson (1876) are rather signifieant and many reflect a history of introduetion, e.g. another false truffle, *Hydnangium carneum*, associated with eucalypts. A record of *Hymenogaster muticus* contradicts Legon & Henrici (2005) who consider the species is known only from the type locality near Bristol, U.K. and a recent unsubstantiated record from Tring, U.K. Paterson also recorded the extremely poorly known *Galera confertus*, originally deseribed from hot-houses. This could well be another introduced species, although the original plate suggests it could be a *Conocybe* sp. (see Legon & Henriei, 2005).

In the currently available data-sets of British fungal reeords, no distinction has been made between the two gardens at Sandyford and Kelvinside. Since the Glasgow garden changed location to the present site, sadly few records exist that can be accurately placed. In 1889 several independent collections of *Clavaria tenuipes* and *C. fragilis* (both collections in the Edinburgh herbarium) were made in the Kelvinside garden and 100 years later *C. tenuipes* and *C. argillacea* (now in the Kew fungarium) were collected. Also in the Kew fungarium is a specimen of the bright red *Pycnoporus cinnabarinus* from the 1800s, which may be assignable to Klotzsch, as he took a particular interest in bracket fungi. There is, however, no further information and it eould be the specimen submitted by Paterson to M.C. Cooke at Kew (Anon., 1877). *P. cinnabarinus* possesses a bright red basidiome and has a eontinental distribution in Europe, although it is found as far north as North Cape in Norway. It is not found along the western shores of Norway and is rare in the British Isles where the only record supported by material in the Kew fungarium is from Murthly, Scotland in 1913. There are a few unsubstantiated records from England. The Glasgow collection might have had its origin in Europe or even farther afield and was possibly introduced on an exotic substrate at the garden.

There is a vouchered Kelvinside record in the Kew fungarium of the carrot-red truffle *Stephanospora caroticolor* reported by Stewart (1901) and now at Kew, a rare species originally described from England,

although it is also known from France, Germany and Switzerland. It is subhypogeous and grows generally under yew (*Taxus* spp.), although it has been found beneath other conifers. It is easily identified by the bright orange colours, especially when the basidiome is cut open. It is closely related to the resupinate genus *Lindtneria* based on the morphology of the basidiospores alone.

An undated collection of "*Stereum ostrea*" is probably a collection of *Stereum lobatum* (= *S. ostrea* var. *lobatum*) that was sent by Paterson to Cooke at Kew for identification. It is a rather unusual curtain fungus, which is widespread in the tropics, especially in the U.S.A. and in southeast Asia, although it is also recorded from several botanic gardens both here and abroad. In Europe it is found on decayed wood in warm tropical glasshouses, again suggesting that it has been introduced. Although larger and more frondose, it is similar to the British *S. gausapatum* and does not "bleed when scratched".

In the same Kew consignment mentioned above *Trichaptum biforme* (as *Polyporus pergamenus*) was noted. This is a widespread polypore in North America and the tropics, which is morphologically similar to our common British *T. abietinum*, but differs by growing on broad-leaved hosts instead of conifers. These specimens and others sent by Paterson to Cooke were published as a note (Anon., 1877) in which it was commented: "Of course no one would expect these to become distinguished foreigners permanently resident in the country". The split-gill (*Schizophyllum commune*) was included in the batch for identification, a species which in the past was restricted in its distribution in the U.K., although it was found at Kelvinside by R.H. Johnstone later in 1901. It has spread rapidly throughout Britain since the Second World War and is now not infrequently found on treated straw-bales in storage.

Subsequent records of fungi from the Kelvinside garden are the result of brief visits and are of relatively common species that would fall into Klotzsch and Paterson's categories of "common and widespread" or "common".

At a British Association for the Advancement of Science meeting held in Glasgow in 1904, the beef steak fungus (*Fistulina hepatica*) was noted by a delegate member whilst on a visit to the Kelvinside garden. In Britain this is a relatively common and widespread bracket fungus, most notably growing on oak (*Quercus* spp.) and sweet chestnut (*Castanea sativa*), and it might be expected on a specimen tree at Kelvinside.

The clavarioid fungi deposited in Kew fungarium from the Kelvinside garden date either from 1899 or from 1989 and represent species that are relatively common and widespread in the British Isles, although *Clavaria tenuipes* recorded at the earlier date has been confused more recently with *C. krieglsteineri*. It has certainly been found in the glasshouse in the Edinburgh Botanic Gardens growing on peaty potting compost. The moor club (*C. argillacea*) has also been found in the temperate glasshouses in Edinburgh amongst ericaceous propagation materials. It is widespread in the British Isles, growing in heathland and moorland, although the species has been separated into two entities on the basis of molecular data. It is probably more common in Scotland than further south. It is assoeiated with members of the Ericaceae with which it has been demonstrated as having a mycorrhizal assoeiation. A third species, white spindles (*C. fragilis*), is widespread and common in Britain in fields and pastures, even growing along grassy verges to trails. After 100 years *C. argillacea* was again found in the Kelvinside garden along with four collections of the equally common yellow club (*Clavulinopsis helvola*, recorded as *C. inaequalis* var. *helvola*) and having the same eeology. Also recorded from the Kelvinside garden is *Ramariopsis* (formerly *Clavaria*) *kunzei*, which is occasionally collected in garden borders and at woodland margins. There is a record of the little known and rare fairy club "*Clavaria* (now *Clavulinopsis*) *candida*". However, from parallels with other fungi found in botanic gardens there is every likelihood that this represents the common and widespread pointed club (*C. acuta*), which often grows amongst potted plants, in garden borders and also in open woodland. There is also material of the ascomycetous *Trichoglossum walteri* from 1889 in the Kew fungarium associated with the fairy club collections; being an earth-tongue, this bears an uncanny resemblance to a club fungus. *T. walteri* apparently requires a similar nutritional environment and was re-determined by R.W.G. Dennis. It is very uncommon and possibly introduced, as it is most frequently found in urban situations in lawns and grassland, whilst the native habitat in the U.K. is unknown. Paterson (1876) had earlier recorded the upright coral *Ramaria* (as *Clavaria*) *stricta*, a fungus which is not uncommon, cropping up in garden borders on wood-chips or woody debris. It is the only British clavarioid fungus that is lignicolous.

In the autumn of 1980 the British Mycological Society visited the Glasgow area and generated some records for the Kelvinside garden (Moodie, 1981). Whereas several sites were visited outside Glasgow centre during that meeting, only a "snatch-like" visit was made to the garden. Most of the fungi found were agarics associated with trees (ectomycorrhizal) amongst which the grey veiled amanita (*Amanita porphyria*) was a surprise. This species is "rare to not common" according to Legon & Henrici (2005) and is often confused with the very variable *A. excelsa*. The latter has been found on later visits to the Kelvinside garden. *A. porphyria* is found in sandy, often rather acidic, pine woodland or *Calluna* heaths, although occasionally it can be associated with oak.

At a field meeting in 2014, 37 species were recorded, with many new additions to the list of fungi previously recorded in the Garden. The list can be found at gnhs.org.uk/biodiversity/GBG_splist.pdf. Most species were expected, but of particular interest were the ear-pick fungus (*Auriscalpium vulgare*) on a eonifer cone, pinecone cap (*Strobilurus tenacellus*), and the holly

parachute (*Marasmius hudsonii*) on a cast holly leaf. Also found were the fragile *Delicatula integrella*, *Hemimycena cucculata* and *Conocybe vestita*, all of which are frequently overlooked on a general foray.

Grassland fungi were found in the garden in 2016, including the parrot mushroom (*Gliophorus* (formerly *Hygrocybe*) *psittacinus*) and butter mushroom (*Hygrocybe pratensis*), both widespread species of grasslands and lawns in Scotland, the latter being recorded also in 1980. The common and widespread orange mosscap (*Rickenella fibula*), found in both grassy and wooded areas, was also only found in 1980, as was the stump puffball (*Lycoperdon pyriforme*), the only U.K. puffball growing on woody substrates, and root rot polypore (*Heterobasidion annosum*), the scourge of the arboriculturist, as it is a very effective parasite of a whole range of woody plants. The pale brittlestem (*Psathyrella candolleana*) has been found in the Kelvinside (and Sandyford) gardens, but this is a widespread and variable species found in shrubberies and disturbed woods and is generally associated with woody debris; it would be expected in a garden setting. Also found in 2016 were the geranium brittlegill (*Russula fellea*), *Lactarius fluens*, a very close relative of the beech milkcap (*L. blennius*) and like it confined to beech, and the purple brittlegill (*R. atropurpurea*), which grows with oak. The beechwood sickener (*R. nobilis*), also found in 2016 and probably better known as *R. mairei*, grows with beech, whilst the ochre brittlegill (*R. ochroleuca*) can be found with a whole range of species from late spring until the first frosts. In contrast, the birch milkcap (*Lactarius tabidus*) grows in frondose woods but generally with birches (*Betula* spp.). Also found in the garden was the soap-smelling *Hebeloma pallidoluctuosum* (related to, yet quite distinct from, the sweet-scented sweet poison-pie (*H. sacchariolens*) and the leopard spotted earth ball (*Scleroderma areolatum*), an ectomycorrhizal species often found on borders in gardens and parks. The 2016 collecting opportunity was a National Fungus Day celebration organised by the Clyde & Argyll Fungus group under the umbrella of the British Mycological Society. In a short space of time 38 species of larger fungi were collected, including both saprotrophic and some ectomycorrhizal species. All the ectomycorrhizal species indicated above are fairly widespread if not very common throughout Scotland. Of particular interest was *Xerocomus cisalpinus* which, although only recently described as new to science, is widespread in disturbed woodland-margins and garden borders. It is closely related to the red cracking bolete (*X. chrysenteron*), with which it has been surely confused in the past. Amongst the non-mycorrhizal larger fungi found was the shaggy scalycap (*Pholiota squarrosa*), growing at the base of an old specimen tree but hardly a threat, and the pale brittlecap mentioned earlier was also on wood. Amongst the saprotrophs found was *Agaricus dulcidulus*, a small true mushroom with an amethyst coloured cap and slightly yellowing stem; it also has small spores and perhaps was least expected. It was also a great pleasure in 2016 to see in a recently tilled area ready for planting a rather impressive, large troop of the stubble rosegill (*Volvariella gloiocephala*), a close relative of the paddy straw fungus (*Volvariella volvacea*), an exotic mushroom served extensively in Chinese restaurants in Glasgow.

MICROFUNGI OF THE SANDYFORD AND KELVINSIDE GARDENS

There is no doubt Klotzsch collected microfungi, but only one in the Scottish collections has been documented as being from Sandyford (Watling, 2014). The collection is filed under *Sphaeria* (*Depazea*) *unedonicola* and was found on leaves of strawberry tree (*Arbutus unedo)*. It is a name which appears to have been applied to a non-sporulating member of the Sphaeropsidales: Phomeae on this host and is another example of a fungus that was introduced to Glasgow. Hooker (Peebles, pers. comm., 2017) also notes a fungus which must have been an introduction to the Sandyford garden, viz. *Taphrina populina* on black poplar (*Populus nigra*), and Paterson amongst his listings for Kelvinside records six microfungi, all on plant remains.

Paterson (1876) records *Myxosporium* (= *Gloeosporium*) *orbiculare*, a fungus attacking cultivated cucurbits, coral spot or pea stick fungus *Nectria cinnabarina* (recently found again in the Kelvinside garden) collected under the name *Nectria ochracea*; and *Stictis phacidioides*, which is now placed in *Marthamyces,* a close relative of the tar spot fungus noted below. Paterson (1876) recorded microfungi now placed in the genera *Apiosporopsis, Coniothyrium, Coryneum, Diaporthe* and *Pestalotiopsis*, the last being a foliar disease which may have been introduced to Kelvinside from foreign parts. A fungus on podocarps (*Podocarpus* spp.) found in the Kelvinside garden in 1933 proved to be a species new to science, viz. *Pestalotiopsis* (as *Pestalotia*) *podocarpi* Dennis, 1934 (Dennis, 1934). This has apparently not been seen since.

Other microfungi recorded from Kelvinside include mildews (Erysiphaceae), two species on *Rhododendron* spp. and one on hogweed (*Heracleum sphondylium*), a wayside plant. The latter was collected in 1980. Two rust-fungi listed by Paterson (1876), viz. *Xenodochus carbonarius* on great burnet (*Sanguisorba officinalis*) and *Endophyllum sempervivi* on houseleek (*Sempervivum* spp.), are both rather significant records, although the latter is known from elsewhere in Scotland, attacking plants in ornamental succulent collections. Four fungi specifically apply to the Kelvinside garden in Boyd's account (1901). The little known cup-fungus *Lachnum* (as *Dasyscypha*) *lanariceps* and *Colletotrichum coccodes* (as *Gloeosporium elasticum*) on dead leaves of rubber fig (*Ficus elastica*) were then the only British records, both attributed to Boyd. *L. lanariceps* is known from Australia, Java, the Philippines and Ceylon, where it is said to grow exclusively on the tree fern *Cyathea walkerae*: it must have been introduced! The other two are diseases: *Graphiola phoenicis* of palms, apparently introduced into many botanic gardens, and the native *Puccinia soldanellae*. Some microfungi form rather obvious fruiting bodies, unlike the usual spots and specks. One

such fungus is dead man's fingers (*Xylaria polymorpha*) found in the Kelvinside garden by a member of the public. As the common name suggests, the fruiting bodies form darkened finger-like structures like mummified human digits. It might be expected on any woody substrate. Another larger ascomycete recorded from the garden is the elf cup *Peziza cerea*, which might have been expected, as it grows commonly in outhouses on old sacking etc. and even in dwellings.

Polycephalomyces tomentosa, recorded as *Blistum ovalisporum* in Moodie (1981), is a distant relative of the vegetable caterpillar fungi (Ophiocordycipitaceae) but, instead of attacking adult insects or their larvae, it probably parasitises a wide selection of slime moulds – myxomycetes, on which it fruits. More widespread are several parasites with specific hosts. During the 2014 foray several were recorded including four rust-fungi: *Uromyces dactylidis* on wood meadow-grass (*Poa nemoralis*), *Puccinia aegopodii* on bishop weed (*Aegopodium podagraria*), *P. sessilis* on *Phalaris* sp. (another grass), and *P. caricina* var. *ribesii-pendula* on sedges. Red spots on *Rumex* caused by *Ramularia rubella*, also a specialised parasite, were evident in the shrubbery. The tar spot *Rhytisma acerinum* on sycamore leaves (*Acer pseudoplatanus*) was in evidence in 2016, an indication of the improvement in air quality since the previous industrial era. The pin-head shiny fungus *Coleroa robertiani* on herb robert (*Geranium robertianum*) and *Trochila craterium* forming whitish spots with small black specks in the centre of ivy leaves (*Hedera* spp.) were both found in 2016, as might be expected. The ergot fungus *Claviceps purpurea* was present on the inflorescences of wood meadow-grass, replacing the ovules with black resting structures (sclerotia). Perhaps the microfungus causing the most visible impaet in the Kelvinside garden was the mould *Cristulariella depraedens* on fading attached leaves of syeamore.

The River Kelvin runs beside the present day Kelvinside garden. Galloway & Elliott (1987) conducted a survey of aquatic fungi in the Kelvin and the Allander Water from October 1986 until January 1987. There is little doubt that, even if not recorded from a site in the garden, data from the Kelvin indicate species potentially present in the garden, as their propagules are dispersed by water currents. A total of 18 different species was recorded from the two Kelvin sites, with *Flagellospora curvula* and *Lemonniera aquatica* being the eommonest. Conidia of *Articulospora tetracladia* and *Clavariopsis aquatica* occurred in good numbers but with greater variation than amongst Allander Water samples. Perhaps this reflects a heavy pollution load in the Kelvin in 1986-7.

An unfortunate recent record made by a member of staff at the Kelvinside garden is of *Phytophthora ramorum* (sudden oak death). Formerly considered to be a fungus but now placed in an unrelated group (Chromista: Peronosporaceae), this will have been introduced into the garden, as has occurred elsewhere in Scotland and the U.K. It is a root parasite and the motile spores allow it to spread from site to site. With a wide range of hosts both arborescent and herbaceous it can become a scourge. Disinfectant control is necessary.

CONCLUSIONS

If the species found in 2016 are anything to go by, taxa labelled "common" by Klotzsch but unlocated, such as the widespread ectomycorrhizal deceiver (*Laccaria laccata*), certainly will be present at Kelvinside. There is no doubt that the changing management of any garden introduces new species even today. It must be realised that fungi can be hidden from view for months of the year, living in the soil etc. and only fruiting ephemerally when favourable conditions prevail; it is only then that their presence can be detected. Molecular techniques are now becoming available which will detect their presence without the need to identify a fruiting body. Some fungi may remain in the soil out of sight for many years before making an appearance.

All species recorded from the Sandyford and Kelvinside gardens are listed in the Appendix to this paper. Some very interesting and noteworthy fungi have been found in the two Glasgow gardens, but there is no doubt that a concerted effort would find many more species. Changes have been seen between the early Klotzsch collections and the present day, mainly due to major changes in the built environment and industrial activities in the city, with some previously rare species having been lost from Glasgow (Watling, 2015). Nevertheless, important mycological contributions have been achieved. There is no doubt that a list of the more common species could easily be amassed to add to the records already available by a few short forays around the grounds and may result even in some surprises, especially if those found in the warm humid conditions of the Kibble Palace are examined in detail! The recent finding by Luka Large of the holly speckle (*Trochila ilicina*), which causes small shiny black pustules on dead holly leaves, shows there is much to do!

ACKNOWLEDGEMENTS

I am deeply grateful to Dick Peebles, who read a draft of this account and supplied more expansive information on key players and some of the record details, Richard Weddle who also read a very early draft, Brian Douglas for information concerning material in Royal Botanic Gardens, Kew, and the staff of the Library of the Royal Botanic Gardens, Edinburgh for their help in tracing obscure publications.

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APPENDIX

Non-lichenised fungi recorded from the Sandyford and Kelvinside gardens

*Significant records. +Undoubtedly introduced. KG, recorded from the Kelvinside garden. SG, recorded from the Sandyford garden. G, records in Glasgow Museums Resource Centre. K, material generated from the 1980 British Mycological Society foray and deposited in Kew. Records with habitat data were generated by the author on 8th October 2016. The year when a record was made is shown for some species.

Basidiomycota
Agaricales
Agaricaceae
Agaricus dulcidulus Schulzer - KG, amongst grass.
Echinoderma asperum (Pers.) Bon (as *Agaricus mariae* Klotzsch) - KG (1876); SG.
**Lepiota* (as *Agaricus*) *clypeolaria* (Bull.) Kummer - KG (1876).
**Leucoagaricus* (as *Agaricus*) *meleagris* (Sow.) Singer - KG (1876).
**Leucocoprinus* (as *Agaricus*) *cepistipes* (Sow.) Pat. - KG (1876).
**Melanophyllum haematospermum* (Bull.) Kreisel (as *Agaricus hookeri* Klotzsch) - KG (1905); SG.
Lycoperdaceae
Lycoperdon pyriforme Schaeff. - KG; G; K.
Vascellum pratense (Pers.) Kreisel - KG, in grass.
Amanitaceae
Amanita excelsa (Fr.) Bertill. - KG, margin of lawn; K.
Amanita muscaria (L.) Lam. - KG; K.
Amanita porphyria A. & S. - KG; K.
Amanita rubescens Pers. - KG, under frondose trees; K.
Bolbitiaceae
Bolbitius titubans (Bull.) Fr. - KG; G.
Conocybe vestita (Fr.) Kühner - KG; G. Note that *Agaricus* (*Galera*) *confertus* Bolton in Paterson (1876) has been assigned to this genus; see below.
Coprinaceae
Coprinellus micaceus (Bull.: Fr.) Vilgalys *et al.* - KG; G.
Coprinopsis lagopus (Fr.: Fr.) Redhead *et al.* - KG; G.
Lacrymaria lacrymabunda (Bull.) Pat. (as *Agaricus tabularis* Peck) - KG, edge of shrubbery; SG.
Parasola plicatillis (Curtis: Fr.) Redhead *et al.* - KG, in grass.
Psathyrella candolleanum (Fr.) Maire - KG; SG; G; K.
Psathyrella gracilis (Fr.) Quél. (= *P. corrugis* f. *gracilis* (Pers.) Konrad & Maubl.) - KG, in grass.
Psathyrella sp. - KG. This is identified as "*Mycena proliferus* Sow." However, the original illustration of *M. proliferus* by James Bolton (1788: Plate 18) is considered by Legon & Henrici (2005) to look very similar to a sterile *Psathyrella*; sterility is a common phenomenon in some dark-spored agarics, making resemble a paler spored species of mushroom.
Crepidotaceae
Inocybe cincinnata (Fr.) Quél. - KG, under *Quercus*?
Inocybe geophylla (Sowerby) P. Kumm. - KG, under *Fagus* and *Quercus*; K.
Inocybe napipes J.E. Lange, - KG, under *Quercus*.
Inocybe rimosa (Bull.) P. Kumm. - KG, several sites under various trees.
Entolomataceae
Entoloma (*Nolanea*) *conferendum* (Britzelm.) Noordel. - KG, in grass under various trees; G.
Hydnangiaceae
*+*Hydnangium carneum* Wallr. - KG (1876); SG.
Laccaria laccata (Scop.) Cooke - KG, several sites, especially under newly planted trees.
Hygrophoraceae
Gliophorus psittacinus (Schaeff.) Herink - KG; K.
Hygrocybe pratensis (Pers.) Murrill - KG, in grass; K.
Marasmiaceae
**Marasmius hudsonii* (Pers.) Fr. - KG; G.
Mycenaceae
Hemimycena (as *Mycena*) *cucculata* (Pers.) Singer - KG; G.
Physalacriaceae
Strobilurus tenacellus (Pers.) Singer - KG; G.
Pluteaceae
Volvariella gloiocephala (DC.) Boekhout & Enderle (as *V. speciosa* (Fr.) Singer) - KG, in vegetable garden in newly manured plot.
Schizophyllaceae
+*Schizophyllum commune* Fr. - KG (1905).
Tricholomataceae
Clitocybe nebularis (Batsch) P. Kummer - KG, in shrubbery.
Delicatula (as *Mycena*) *integrella* (Pers.) Fayod - KG; G.
Gymnopus (as *Collybia*) *inodorus* (Pat.) Anton. & Noordeloos - KG; G.

**Lepista saeva* (Fr.) P.D. Orton - KG (1978).
Lepista (as *Agaricus*) *sordida* (Schumach.) Singer - KG, (1897).
Melanoleuca cognata (Fr.) Konrad & Maublanc - KG; G.
Melanoleuca grammopodia (Bull.) Fayod - KG, by side entrance in grass and edge of lawn in main garden.
Melanoleuca strictipes (P. Karst.) Schaeff. - KG, in shrubbery.

Auriculariales
Auricularia auricula-judae (Bull.) Wettst. - KG; G.

Boletales
Xerocomaceae
Boletus cisalpinus Simoni *et al.* - KG, under *Quercus*.
Sclerodermataceae
Scleroderma areolatum Ehrenb. - KG, under *Quercus*.

Cantharellales
Cantharellaceae
Cantharellus cibarius Fr. - KG, (1890).
Clavariaceae
Clavaria acuta Sow. (as *C. candida* certified by M.C. Cooke, but see discussion in text) - KG (1876).
Clavaria argillacea Pers. - KG (1899, 1980); K.
Clavaria fragilis Holmsk. - KG (1899); K.
Clavaria tenuipes Berk. & Br. - KG (1899); K.
Clavulinopsis helvola (Pers.) Corner - KG; three collections deposited in K.
Ramariopsis kunzei (Fr.) Corner - KG; G.

Cortinariales
Cortinariaceae
Collection agreeing in all ways with *Cortinarius rigens* (Pers.) Fr. - KG, under *Quercus*.
Hymenogastraceae
Gymnopilus junonius (Fr.) Orton - KG? (1876).
Hebeloma crustuliniforme (Bull.) Quél. - KG, several sites, edge of line of trees; also recorded in 1897 and 1905.
Hebeloma pallidoluctuosum Gröger & Zschiesch. - KG, under frondose trees amongst grass.
**Hebeloma radicosum* (Bull.) Ricken - KG (1876).
**Hymenangium album* Klotzsch - KG; SG; K.
**Hymenogaster muticus* Berk. & Br. - KG (1876).
Strophariaceae
Pholiota squarrosa (Oeder) P. Kummer - KG, base of living *Salix*.
Psilocybe montana (Pers.) P. Kummer - KG; G.

Exobasidiales
Graphiolaceae
*+*Graphiola phoenicis* (Moug. ex Fr.) Poit. - KG (1905).

Fistulinales
Fistulinaceae
Fistulina hepatica (Schaeff.) With. - KG (1876).

Ganodermatales
Ganodermataceae
Ganoderma australe (Fr.) Pat. - KG; G.

Gomphales
Geatraceae
Geastrum triplex Jungh. - KG (1905).
Gomphaceae
Ramaria stricta (Pers.) Quél. - KG (1876).

Hymenochaetales
Hymenochaetaceae
Rickenella fibula (Bull.) Raithelh. - KG; K.
Hyphondontaceae
Lyomyces sambuci (Pers.) Karst. - KG, on fallen woody trash in shrubbery; G.
Schizoporaceae
Schizopora paradoxa (Schrad.) Donk - KG, on fallen branch.

Polyporales
Coriolaceae
Datronia mollis (Sommerf.) Donk - KG; G.
*+*Pycnoporus cinnabarinus* (Jacq.) Karst - KG; K.
Trametes versicolor (L.) Pilát - KG; G.
*+*Trichaptum biforme* (Fr.) Ryvarden - KG; K.
Hyphodermataceae
Hyphoderma praetermissum (P. Karst.) Erikss. & Strid - KG, on fallen branch.
Hyphoderma (*Basidiodendron*) *radula* (Fr.) Donk - KG, on fallen twig.
Polyporaceae
Polyporus tuberaster (Jacq. ex Pers.) Fr. - KG, with blackened swollen base, on buried wood.

Russulales
Auriscalpiaceae
Auriscalpium vulgare Gray - KG; G.
Bondartzewiaceae
Heterobasidion annosum (Fr.) Brefeld - KG; K.
Peniophoraceae
Peniophora limitata (Chaillet ex Fr.) Cke. - KG; G.
Peniophora lycii (Pers.) Höhn. & Litsch. - KG; G.
Russulaceae
Lactarius fluens Boud. - KG, with *Fagus*; K.
Lactarius tabidus Fr. - KG, in shrubbery under mixed trees.
Russula atropurpurea (Krombh.) Brizelm. - KG, with *Quercus*.
Russula fellea (Fr.) Fr. - KG, with *Fagus*; K.
Russula nobilis Velen. - KG, with *Fagus*.
Russula ochroleuca Fr. - KG, several collections, various trees including *Fagus*, *Quercus* and *Acer pseudoplatanus*; K.
Stereaceae
Stereum hirsutum (Willd.) Pers. - KG, on fallen branch; G.
*+*Stereum ostrea* (Blume & Nees) Fr. - KG; K.
Stephanosporaceae
**Stephanospora caroticolor* (Berk.) Pat. - KG (1901); K.

Tremellales
Exidiaceae
Exidia glandulosa (Bull.) Fr. - KG (1905).

Uredinales
Phragmidiaceae
**Xenodochus carbonarius* Schtdl. - KG (1876).
Pucciniaceae
*+*Endophyllum sempervivi* (A.& S.) de Bary - KG (1876).
Puccinia aegopodii (Schumach.) Mart. - KG; G.
Puccinia caricina var. *ribesii-pendulae* (Hassler) Hend. - KG; G.
Puccinia sessilis Schroet. - KG; G.
Puccinia soldanellae (DC.) Fuckel - KG (1905).
Uromyces dactylidis Otth. - KG; G.

Ascomycotina
Clavicipitales
Clavicipitaceae
Claviceps purpurea (Fr.) Tul. - KG, on inflorescences probably of *Poa nemoralis*.
Ophiocordycepitaceae
Polycephalomyces (as *Blistum*) *tomentosus* (Schrad.) Seifert - KG; K.

Diaporthales
Apiosporiopsidaceae
Apiosporopsis (as *Sphaeria*) *carpinea* (Fr.) Mariani - KG (1876).
Diaporthaceae
Diaporthe (as *Sphaeria*) *pardalota* (Mont.) Nits. ex Fuckel - KG (1876).
Mycosphaerellaceae
Ramularia rubella (Bon.) Nannf. - KG; G.
Pseudovalsaceae
Coryneum microstictum Berk & Br. - KG (1876).

Dothideales
Dothideaceae
Dothidea sambuci (Pers.) Fr. - KG (1928).

Erysiphales
Erysiphaceae
Erysiphe azaleae (U. Braun) U. Braun & S. Takam. - KG, on undersurface of living attached leaves of elepidote (large leaved) *Rhododendron* hybrids.
Erysiphe heraclei DC. - KG; K.
Oidium (type of spore) probably of *Phyllactinia guttata* (Wallr.) Lév. - KG, smothering living leaves of reddening shoots of a *Rhododendron* cultivar.

Geoglossales
Geoglossaceae
**Trichoglossum walteri* (Berk.) Durand - KG (1899); K.

Helotiales
Dermataceae
*+*Colletotrichum coccodes* (Wallr.) Hughes (as *Gloeosporium elasticae* Cooke & Massee) - KG (1904).
**Gloeosporium orbiculare* (Berk.) Berk. - KG (1904).
Hormotheca robertiani (Fr.) Höhn. - KG, on living *Geranium robertianum* leaves in shrubbery.
Trochila craterium (DC.) Fr. - KG, forming whitish areas on fading *Hedera* leaves.
T. ilicina (Nees ex Fr.) Greenh. & Morgan-Jones - KG, on cast leaves of *Ilex*.
Hyaloscyphaceae
*+ *Lachnum lanariceps* (Cooke & Phillips) Spooner - KG, collected by W. Stewart.
Phacidiaceae

Phacidium multivalve (DC.) Kunz. - KG; G.
Sclerotiniaceae
Cristulariella depraedens (Cooke) Höhn. - KG, on attached fading leaves of *Acer pseudoplatanus*.

Hypocreales
Nectriaceae
Nectria cinnabarina (Tode) Fr. - KG (1876).

Pezizales
Pezizaceae
Aleuria aurantia (Pers.) Fuckel - KG, side of path.
Peziza cerea Sow. - KG (1876).

Pleosporales
Pleosporaceae
Macrosporium macrosporum (Zimm.) Nishikado & Oshima (as *Alternaria macrospora* Zimm.) - KG (1928).

Rhytismatales
Rhytismataceae
**Marthamyces* (as *Stictis*) *phacidioides* (Fr.) Minter - KG (1905).
Rhytisma acerinum (Pers.) Fr. - KG, on attached and fallen leaves of *Acer pseudoplatanus*; G.

Taphrinales
Taphrinaceae
Taphrina populina (Fr.) Fr. - SG (1825), recorded by Hooker (see main text).

Xylariales
Amphisphaeriaceae
+*Pestalotiopsis* (as *Pestalotia*) *guepinii* (Desm.) Steyaert. - KG (1876).
+**Pestalotiopsis* (as *Pestalotia*) *podocarpi* (Dennis) X.A. Sun & Q.X. Ge - KG (1933).
Diatrypaceae
Diatrype stigma (Hoffm.) Fr. - KG (1905).
Xylariaceae
Hypoxylon fragiforme (Pers.) Kickx. - KG; G.
Xylaria carpophila (Pers.) Fr. - KG (1905).
Xylaria hypoxylon (L.) Grev. - KG; G.
Xylaria polymorpha (Pers.) Grev. - KG (1876).
Ustulina vulgaris Tul. & Tul. - KG; G.

Unidentifiable
**Sphaeria* (*Depazea*) *unedonicola* Klotzsch - SG; unsporulating and therefore unidentifiable; *vide* Grove (1935-37) and main text.

Chromista
Perenosporaceae
Phytophthora ramorum Werres *et al.* - KG, isolated from root fragments.

The brown lacewing *Hemerobius atrifrons* (Neuroptera: Hemerobiidae) in Glasgow Botanic Gardens, Scotland

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Two specimens of the brown lacewing *Hemerobius atrifrons* McLachlan 1868 were found in the moth trap at Glasgow Botanic Gardens on 4th Oetober 2016. The species is described as "widespread but local in England, Wales and Scotland, strictly associated with larch trees *Larix decidua*" (Plant, 2016).

This is the first record for Glasgow, and apparently one of rather few lowland records in Scotland. There is a single specimen of *Larix decidua* in the Botanic Gardens some 100 m from the site of the moth trap.

The only other modern Scottish lowland record was made by E.G. Hancock in 1987 at Cander Moss near Stonehouse in South Lanarkshire (NBN, 2018). Historical records from the "Clyde" area were: at Cadder Wilderness SSSI in East Dunbartonshire, just over the Glasgow boundary beyond Possil Marsh in 1880; and at Bridge of Weir (Renfrewshire) in 1884; these were found by J.J.F.X. King (1855-1933) in the early part of his entomological career, and the specimens form part of the King collection at the Hunterian Museum, University of Glasgow. The remaining Scottish specimens of *H. atrifrons* in King's vast collection are from north of the highland line. Similarly, specimens and literature references at the National Museum Collections Centre (NMCC) in Edinburgh are all from upland areas.

The "strict" association with larch (Plant, 2016), conflicts with reports in other sources, which mention Scots pine (*Pinus sylvestris*) (Elton, 1966), and "other conifers" (McEwen *et al.*, 2001) as alternative hosts.

It seems possible that the relative lack of lowland records of this species in Scotland is partly a reflection of recorder effort, as the U.K. distribution map for the species (NBN, 2018) shows verified records in such areas as north Kent and East Anglia (the highest point in East Anglia is Beacon Hill at 103 m (Wikipedia, 2018)). However, Séméria & Berland (1988) describe *H. atrifrons* as a species of mountainous regions, chiefly found at altitudes of 1,000 - 1,800 m, but concur with Plant (2016) that it is quite localised. This view may therefore have influenced recent Scottish recorders' expectations.

In addition, *H. atrifrons* is a comparatively small insect, and, along with other members of the Hemerobiidae, could often have been left unidentified before the publication of the AIDGAP key. However, in the field this species is potentially one of the more easily identified hemerobiids in view of its combination of darkened patches on the forewings, a fully glossy-black face, and a thorax with a median yellow stripe (though it is generally advisable also to check details of the wing venation under magnification). It seems quite likely that focused reeording in lowland areas, such as the larger Glasgow parks, may generate further records.

The lowland records mentioned above, along with King's upland records, have been added to the Glasgow Museums Biological Record Centre database (which previously held no records of this species).

I am grateful to Jeanne Robinson for records from the King collection, to Ashleigh Whiffin for facilitating access to the NMCC collections and SIRI (Scottish Insect Records Index), to Riehard Sutcliffe for information about specimens in the Glasgow Museums collections, and to Craig Macadam (Buglife) for useful comments on distribution.

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Non-avian vertebrates in Glasgow Botanic Gardens

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There has been very little systematic recording of the vertebrates (other than birds) in Glasgow Botanic Gardens following the article about mammals that was part of the original "On the Wildside" supplement (Sutcliffe, 1998). It appears that, since then, there has been little ehange in the species present. However, there have been several new records, which are outlined in this update.

Only a single fish, a three-spined sticklebaek (*Gasterosteus aculeatus*), appears to have been recorded in the Botanic Gardens itself, in the former pond beside the Kibble Palace in 1994. A stone loach (*Barbatula barbatula*) and a minnow (*Phoxinus phoxinus*) were both seen in the River Kelvin beside the gardens in 1983; and an eel (*Anguilla anguilla*) was seen there in 2016.

The only amphibians recorded in the gardens are common frog (*Rana temporaria*) and newts. The former pond beside the Kibble Palace used to support frogs. Some frog-spawn was removed and taken to Bingham's Pond about 1,500 m to the northwest in early 2004, in preparation for restoration work on the Kibble Palace, during which the old pond was destroyed. A new pond has since been established and adult frogs, tadpoles and newt eggs were recorded there in 2011. Adult frogs and immature newts (species undetermined) were reeorded in 2017. Palmate newts (*Lissotriton helveticus*) are now known to breed in the small stone artifieial ponds at the back of the Hopkirk Building.

For just over two weeks during August and September 2017, the Botanic Gardens played host to the entertainment *Jurassic Kingdom* - several "animatronic dinosaurs" that are reconstructions of Jurassic giants and which attracted large erowds. These are the only "reptiles" to have been recorded in the gardens!

New speeies of mammals have been confirmed. The presence of the wood mouse (*Apodemus sylvaticus*) was long suspected but confirmed only in 2017. There were three records of an otter (*Lutra lutra*) (possibly the same individual) during December 2010 between the Flint Mill and 80 m upstream of the Humpback Bridge below the Kibble Palace, confirming the speeies' presence along the River Kelvin. Grey squirrels (*Sciurus carolinensis*) eontinue to delight many visitors during the day. Red foxes *Vulpes vulpes* are regular visitors when the gardens are closed at night and there was a fox den on the river-bank close to Ha'penny Bridge on the River Kelvin in 2008.

Bats are still regularly observed feeding around the gardens at night. Since the earlier paper (Sutcliffe, 1998), pipistrelle bats have been "split" and two species are now recognised. They are very similar to look at, but eall at different frequencies (45 kH and 55 kH), and so can be distinguished using bat detectors. Both the common pipistrelle (*Pipistrellus pipistrellus sensu stricto*) and the soprano pipistrelle (*P. pygmaeus*) have been recorded in the gardens. Daubenton's bats (*Myotis daubentonii*) are regularly seen feeding over the River Kelvin during the annual bat and moth nights held in the Botanic Gardens. The Clyde Bat Group bring along powerful spotlights and bat detectors, allowing those who attend to both see and hear the enhanced echo-location sounds of the bats as they hunt over the water. Since they have been recorded nearby in Hyndland, it is possible that the brown long-eared bat (*Plecotus auritus*) visits the Gardens, and Natterer's bat (*Myotis nattereri*) (nearest record: Rouken Glen on the south side Glasgow) eould also be present (P. Emslie, pers. comm.).

Table 1 provides a list of all non-avian vertebrate species recorded in Glasgow Botanic Gardens. In view of the dates of some of the "Latest records", particularly those of fish and rodents, there is obviously a need for a systematic, and preferably quantitative, survey of all non-avian vertebrate groups currently present in the Gardens. Future updates will be available at www.gnhs.org.uk/biodiversity/GBG_splist.pdf.

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Species	Common name	Latest record
Fish		
Anguilla anguilla	eel	2016
Barbatula barbatula	stone loach	1983
Gasterosteus aculeatus	three-spined stickleback	1994
Phoxinus phoxinus	minnow	1983
Amphibians		
Lissotriton helveticus	palmate newt	2018
Rana temporaria	common frog	2018
Mammals		
Apodemus sylvaticus	wood mouse	2017
Canis lupus ssp. *familiaris*	domestic dog	1991
Capreolus capreolus	roe deer	1997
Erinaceus europaeus	hedgehog	1998
Felis catus	feral cat	1997
Lutra lutra	otter	2010
Microtus agrestis	field vole	1997
Mus musculus	house mouse	1997
Myodes glareolus	bank vole	1997
Myotis daubentonii	Daubenton's bat	2017
Neovison vison	American mink	1998
Oryctolagus cuniculus	rabbit	2018
Pipistrellus pipistrellus	common pipistrelle	2001
Pipistrellus pygmaeus	soprano pipistrelle	2018
Rattus norvegicus	brown rat	1997
Sciurus carolinensis	grey squirrel	2018
Vulpes vulpes	red fox	2008

Table 1. Non-avian vertebrates recorded from Glasgow Botanic Gardens. This is an updated version of the list at: www.gnhs.org.uk/biodiversity/GBG_splist.pdf.

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SHORT NOTES

Largest wild crab apple (*Malus sylvestris* (Linnaeus) Mill.) in Scotland on the shores of Loch Lomond

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While completing wildlife surveys on the east shore of Loch Lomond an unusually large crab apple (*Malus sylvestris* (Linnaeus) Mill.) was found (Fig. 1A,B). In October 2016 its height was measured as 12 m. This height is exceeded by a crab apple of 17 m recorded at Tunbridge Wells, Kent in the database of the Tree Register of the British Isles (TROBI) (2017). However, the girth of the Loch Lomond tree of 410 cm measured at 0.5 m above ground level (a.g.l.) in April 2017 (Fig. 2) makes it apparently the Champion Tree of its species for Britain and Ireland, as listed by TROBI. One other, a huge tree 550 cm in girth (at 0.5 m a.g.l.), located at Brignall, Barnard Castle, Co. Durham is a coppice and so not eligible as a Champion Tree (although it may be the largest by volume). According to the TROBI database (2017) the crab apples closest in girth to the Loch Lomond tree are: Clapgate Gill, Richmond, North Yorkshire, 420 cm "fallen but alive" (2010); Tipperary, Ireland, 401 cm at 0.5 m a.g.l. (2010); Croxdale Hall Park, Co. Durham, 355 cm; Stobo, Peebles, Borders, 290 cm (2012); and St. Boswells, Borders, 242 cm at 1.5 m a.g.l. (2002).

The crab apple, the only native apple tree in the U.K., is present throughout Scotland, including some islands, but with most found in the southern half of the country (NBN Atlas, 2017). However, increasingly, it is becoming rare throughout its European range due to a combination of the low economic value of both the timber and fruit, and with the species having limited competitive growth characteristics, being usually relatively short and having high light requirements (Stephan *et al.*, 2003; Wagner *et al.*, 2014). Furthermore, the genetic integrity of the wild crab apple is threatened by the spread of the domesticated orchard apple (*Malus* x *domestica* Borkh.) with which *M. sylvestris* hybridizes (Larsen *et al.*, 2006; Wagner *et al.*, 2014). Studies of chloroplast DNA variation in trees across Europe revealed that up to 11% of *M. sylvestris* were hybrids with *M.* x *domestica* (Coart *et al.*, 2006).

To confirm the status of the Loch Lomond crab apple it was important to establish that it was *M. sylvestris* and not *M.* x *domestica*, or a hybrid between the two. *M. sylvestris* can be identified by examination of features including the shoots, leaves, flowers and fruit. Importantly, genetic analysis has shown that there is much variation in some of these features with, consequently, leaf hairiness (pubescence) and fruit size thought to be the most reliable way to distinguish the two species and hybrids (Wagner *et al.*, 2014).

Fig. 1. A crab apple (*Malus sylvestris*) growing on the shores of Loch Lomond in 2017, 23rd April (A) and 9th May (B). It was 12 m in height, unusually tall for the species. (Photos: C.J. McInerny)

Fig. 2. The trunk of a crab apple (*Malus sylvestris*) growing on the shores of Loch Lomond, 23rd April 2017. Its girth of 410 cm, measured at 0.5 m above ground level (a.g.l.), makes it the largest recorded example of the species in Scotland and the Champion Tree of its species for Britain and Ireland, as listed by the Tree Register of the British Isles (TROBI) (2017). (Photo: C.J. McInerny)

Leaf hairiness (pubescence)

M. sylvestris leaves are almost hairless, *ca.* 6 cm in size, oval in shape and with small triangular teeth, while the leaves of *M.* x *domestica* and hybrids are larger, woolly beneath and have irregular teeth (Wagner *et al.*, 2014). The difference in leaf hairiness is most noticeable in late summer and autumn. Similarly in spring the shoots are hairless, whereas the shoots of *M.* x *domestica* and hybrids are slightly hairy.

On examination, the leaves of the Loch Lomond tree in April 2017 were found to be hairless, small (equal to or less than 6 cm), oval and with small triangular teeth (Fig. 3B,C). The leaves remained hairless through to October (Fig. 3C). Likewise the shoots in April 2017 were found to be hairless. These characteristics indicate *M. sylvestris* (Wagner *et al.*, 2014).

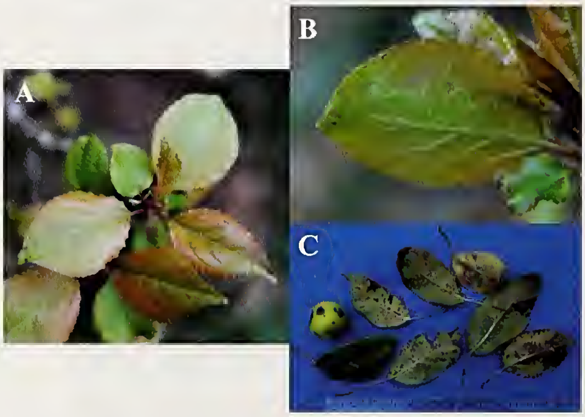

Fig. 3. The upper leaf (A) and lower leaf (B) of a crab apple (*Malus sylvestris*) growing on the shores of Loch Lomond, 30th April 2017. The lack of leaf hair remained until autumn (B), these photographed on 8th October 2017. That the leaves lack hair (pubescence), particularly on the underside, is characteristic of the species and excludes both the orchard apple (*M.* x *domestica*) and hybrids of *M. sylvestris* and *M.* x *domestica*. (Photos: C.J. McInerny)

Flower colour

The flowers of *M. sylvestris* are largely white, developing from pink buds (Wagner *et al.*, 2014). Instead, *M.* x *domestica* produces white flowers with pink shading from rich pink buds. Hybrids trees also produce pinker flowers.

On examination, the buds and flowers of the Loch Lomond tree in May 2017 were found to be pink on first emergence (Fig. 4A,B), but becoming mainly white on maturity (Fig. 4C,D). A few of the mature flowers had some pink (Fig. 4D), but the majority were mostly white. Again this is consistent with *M. sylvestris.*

Fig. 4. The shoots (A) and flowers (B-D) of a crab apple (*Malus sylvestris*) growing on the shores of Loch Lomond, 23rd April and 9th May 2017. That the flowers are mostly white is a characteristic of the species. (Photos: C.J. McInerny)

Fruit size

M. sylvestris fruits are less than 40 mm, whereas fruits of *M.* x *domestica* are at least 40 mm and even larger in hybrids (Wagner *et al.*, 2014). The fruit size of the Loch Lomond tree was measured in October 2017 with the apples found to be 20-30 mm (Fig. 5A,B) indicating *M. sylvestris.*

This combination of observations suggests that the Loch Lomond tree is a wild crab apple *M. sylvestris* and as such is the largest reported living specimen in Scotland. A tree of this size is likely to be at least 160 years old. We plan to list it with TROBI (2017) as the Champion Tree of this species for Britain and Ireland.

For those who wish to view this magnificent living organism it can be found at the Cashel Forest Reserve (http://www.cashel.org.uk/index.html), 6 km north of Balmaha on the east shore of Loch Lomond. The tree is at the south corner of "Memorial Way", also known as the "Blue Loop", most easily seen about 100 m further southeast along the "Red Loop" trail at NS4020093751.

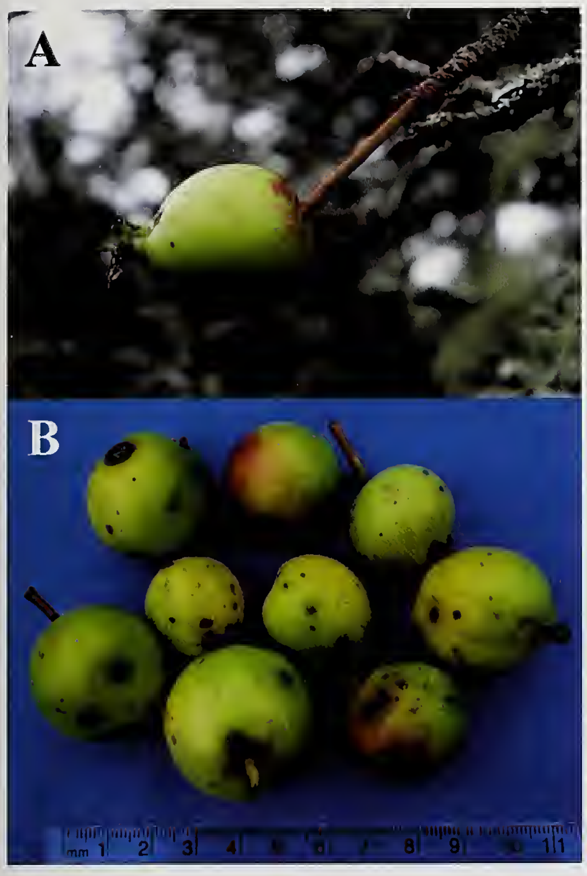

Fig. 5. Fruits (A,B) of a crab apple (*Malus sylvestris*) growing on the shores of Loch Lomond, 8th October 2017. That the fruits are smaller than 40 mm is indicative of the species, and excludes the both the orchard apple (*M.* x *domestica*) and hybrids of *M. sylvestris* and *M.* x *domestica.* (Photos: C.J. McInerny)

ACKNOWLEDGEMENTS
We thank Fiona Inches of The Royal Botanic Garden Edinburgh for advice on crab apple identification, and David Alderman of TROBI for information on the Champion Tree listings. We thank an anonymous reviewer for improvements to the text.

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The collared earthstar (*Geastrum triplex*) in the Glasgow area, Scotland

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The collared earthstar (*Geastrum triplex*) is a curious fungus with a distinctive mushroom fruiting body that is rare in Scotland. Here I report two observations of the species in the Glasgow area.

Eighteen species of earthstars of the genus *Geastrum* have been recorded in the U.K., but most are uncommon, with some on the *Red Data List of Threatened British Fungi* (Evans *et al.*, 2006; Phillips, 2006; NBN Atlas, 2018). The genus has a southern distribution with only ten species recorded in Scotland, where all are rare. The collared earthstar is the most reported, but with a limited distribution: the NBN Atlas lists only 16 records, with the majority of these from the south-east of Scotland in Lothian, Edinburgh and the Scottish Borders (NBN Atlas, 2018). Just one record is assigned to west Scotland in Glasgow, from Govan on 17th November 2004. However, more records for west Scotland have been deposited at the Glasgow Museums Biological Records Centre (GMBRC) from up to 16 different locations across Glasgow, all since 2007, mostly in public parks. It appears that the fungus first appeared in Glasgow about 14 years ago, with a subsequent spread across the city, although this apparent trend may in part reflect observer effort.

Such a restricted Scottish distribution is surprising as the species has a widespread and cosmopolitan range, being found on all continents around the world apart from Antarctica, and being common in some areas, including England (Jordon, 2004). However, recent genetic

studies reveal that a taxonomic revision is required as taxa identified as *G. triplex* from different continents are polyphyletic, not sharing a common ancestor, suggesting that instead multiple species are involved (Kasuya *et al.*, 2012).

The collared earthstar is a saprotrophic fungus, obtaining nutrients and energy from decaying matter such as leaf-litter, detritus and humus. In Europe it is usually found on deciduous forest floors, often associated with beech trees (*Fagus sylvatica*), with the mushroom fruiting bodies visible above ground from late summer to late autumn.

The mushroom fruiting body of collared earthstar is distinctive in shape and appearance (Figs. 1-3). When first erupting above ground it is brown and bulb-shaped, 3-5 cm in diameter (Fig. 1). On development the bulb splits, with the outer layer forming four to eight pointed spongy white rays, 5-10 cm in diameter, revealing a similarly pale spore-sac, creating the earthstar (Fig. 2). The rays subsequently bend back underneath the fruiting body, leaving the spore-sac on a saucer-shaped base (Fig. 3).

Fig. 1. Collared earthstars (*Geastrum triplex*), Baron's Haugh, Motherwell, North Lanarkshire, September 2015, showing the stages of the fruiting body development and emergence. The bulbs are 3-5 cm in diameter, and the stars 5-10 cm. (Photos: C.J. McInerny)

Fig. 2. Fully opened collared earthstars (*Geastrum triplex*), Baron's Haugh, Motherwell, North Lanarkshire, September 2015. The stars are 5-10 cm in diameter. (Photo: C.J. McInerny)

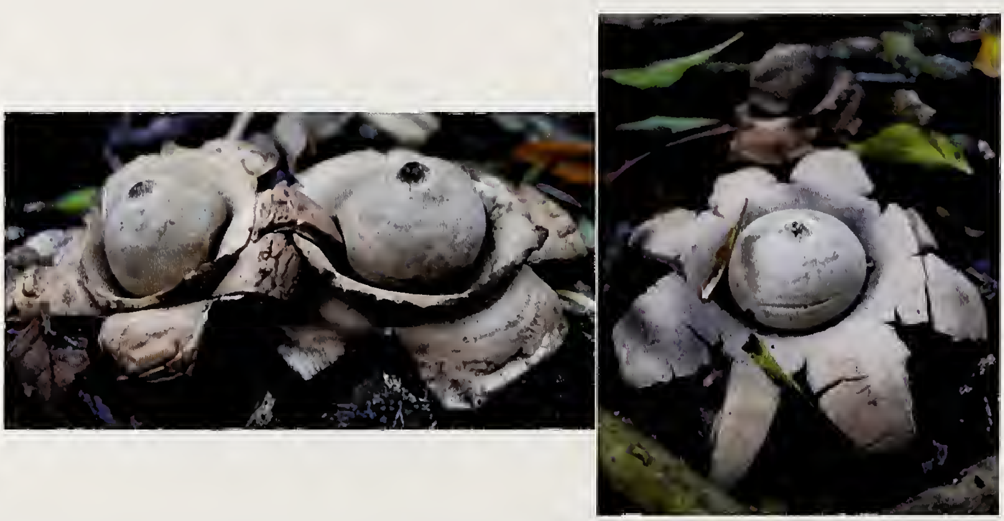

Fig. 3. Fully developed collared earthstars (*Geastrum triplex*), Victoria Park, Glasgow, October 2018. The stars are 5-10 cm in diameter. (Photos: C.J. McInerny)

Two new sites in the Glasgow area have collared earthstars, which have been fruiting for a number of years, one since at least 2015. The first site is at Baron's Haugh, Motherwell, North Lanarkshire (NS755551), with the fungi under pine trees (*Pinus* sp.) in mixed woodland (Figs. 1, 2). The second site is in Victoria Park, Glasgow (NS541672), amongst shrubs and trees adjacent to a children's play area (Fig. 3).

The species could be found elsewhere in west Scotland. It is hoped that publishing this note will alert observers to the distinctive appearance of the collared earthstar allowing others to find this beautiful fungus in new locations.

ACKNOWLEDGEMENTS
I thank Davie Abraham for alerting me to the earthstars in Motherwell, and Myles O'Reilly those in Victoria Park; and to GMBRC for other Glasgow records. Thanks to an anonymous reviewer for improvements to the text.

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Recent spread of *Lactuca serriola* (prickly lettuce) noted in Glasgow during 2017

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Lactuca serriola (prickly lettuce, or compass plant) is a tall plant which can be found on hard waste ground, roadsides and pavements. It grows in two distinct forms: forma *serriola*, with cut leaves (Fig. 1), and forma *integrifolia*, with entire leaves (Fig. 2). While very common for centuries in the south-eastern region of England, it has been spreading north only in recent years, becoming common in Birmingham since 2000, and thence northwards to Manchester, north Wales and Scotland.

Fig.1. *Lactuca serriola* (prickly lettuce), forma *serriola* growing in Glasgow during 2017. (Photo: M. Philip)

Fig. 2. *Lactuca serriola* (prickly lettuce), forma *integrifolia* growing in Glasgow during 2017. (Photo: M. Philip)

Keith Watson stated in *The Flora of Renfrewshire* that the species is "very rare in Scotland" and noted only a single record for vice-county 76 (VC76) at King's Inch, Braehead in 2012 (Watson, 2013). *The Changing Flora of Glasgow* also mentions just one record at Milngavie Station (VC99) in 1976 (Dickson *et al*., 2000). Prior to 2010, there were only two records for VC77, both within the City of Glasgow. The first noted occurrence was in 1918 as a casual at Kelvingrove. Subsequently, there were no more records in the 20th century. The second record is dated 20th September 2001, near King George V Dock. The latter was documented by the late Peter Macpherson (Botanical Society of Britain and Ireland (BSBI) recorder for Lanarkshire, 1979-2015). According to *The Flora of Lanarkshire*, it was then seen twice in 2010, twice in 2011, and once more in 2012 (Macpherson, 2016). A further single in 2015 means that, by the end of 2015, there had been a total of just eight records in VC77. It should also be noted that, at the time of writing, there is a total of only 18 other records for this species in the whole of Scotland, outside Lanarkshire.

Thanks to a general increase in botanical activity in the vice-county, and in particular the recent extensive urban fieldwork carried out by Malcolm Macneill throughout Glasgow, numerous sightings of prickly lettuce were reported in 2017. Following correspondence with Dr. Richard Carter (BSBI referee for the genus), reference to published literature, and the compilation of detailed photographic records by Peter Wiggins, all contemporary sightings have now been assigned to one of the two formae. Approximately two thirds of local records are forma *integrifolia*, and one third forma *serriola*.

Prickly lettuce has now been recorded over 40 times in VC77, in 24 different monads (in 12 different tetrads) in greater Glasgow, from Shieldhall in the west, to Cambuslang in the east - a range of over six miles. All records are within ~1.5 km of the River Clyde, and most are close to railway lines.

In the above correspondence, Dr. Carter points out that the species is known to be eapable of "epidemic spread" under favourable conditions, and this may be what we have witnessed in Glasgow during 2017. It will be of great interest to discover whether the sudden upsurge of the species in the Glasgow area is part of a wider spread in Seotland, or whether it is a local phenomenon. Further work is needed to explain why it should have occurred at this time. Since Glasgow has seen almost constant urban development across wide areas for decades providing much suitable habitat, a small recent climatic temperature increase would seem the more likely triggering factor. Also, it will be interesting to see whether 2017 represents a sustainable increase, or just a "flash in the pan".

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An occurrence of albino common frog (*Rana temporaria*) spawn at Pollok Country Park, Glasgow

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On the afternoon of 25th March 2018, whilst undertaking regular surveys of common frog (*Rana temporaria*) spawning grounds for the presence and number of spawn clumps, I discovered an unusual clump of spawn wherein the embryos were bright white (Fig. 1). Forty-two other clumps of spawn were present at the pond located within Pollok Country Park at NS5526862232, of which no others appeared different from typical spawn clumps. White embryos can be the result of two phenomena - infertility (Froglife, 2018) or albinism (Smallcombe, 1949).

Fig. 1. Amelanistic common frog (*Rana temporaria*) spawn clump *in situ* beside normally coloured frog spawn clumps at a Pollok Park, Glasgow pond on 25th March 2018. (Photo: E. Paterson)

A small sample of white eggs (*ca.* 100) was removed and maintained to ascertain the nature of the colour abnormality, the remainder of the eggs being left *in situ*. The spawn was placed in a 10 litre plastic fish tank, in water that was collected both from the natal site and from a pond in East Kilbride, with a few strands of *Elodea* sp. algae, some *Lymnaea* sp. snails, and *Daphnia* sp. water fleas. The tank was located on a domestic windowsill and was subjected to direct sunlight. After the larvae developed and lost their gills, supplemental food was provided in the form of boiled cabbage and the algae growing in the water.

Eight days after collection, the eggs had developed to the "neural fold" or "rotation", Gosner stages 14 and 15 (Gosner, 1960; Fig. 2). The larvae hatched and developed as expected. By the 19th day, the tadpoles had reached Gosner stage 23, were approximately 15 mm in length, and had begun to develop a darkened colouration (Fig. 3).

On the 29th day, all the larvae died for reasons unknown. However, with unusually warm weather the temperature of the tank water may have exceeded the critical thermal maximum for common frog larvae (Turriago *et al.*, 2015) owing to the small container size in which they were maintained being placed in direct sunlight. This unfortunate loss meant that the development of the larvae could not be observed through to metamorphosis.

The appearance of darkened colouration during the development of amelanistic tadpoles has been noted by other authors (Cahn, 1925; Smallcombe, 1949). This may result from the body wall of the larvae being transparent, and the darkened colouration being an attribute of the developing organs. This suggestion is supported by the observation that the tail of the tadpoles remained transparent. However, it has been noted that albinism in anuran larvae is a maternal defect, and that as the larvae grow their individual genetic material begins to develop chromatophores within the skin resulting in typical colouration through metamorphosis (Cahn, 1925; Smallcombe, 1949).

Albino or unusually coloured frogs are uncommon and are rarely reported. Mendel (1990) provides a useful review of records of albino frogs in England. More recently, albino spawn has been noted in Carmarthenshire, Wales (BBC, 2008) and a xanthrochromic adult has been recorded in Cambridge, England (Allain & Goodman, 2017). However, this Scottish observation warrants note and further exploration in successive years as the presence, and persistence, of amelanistic animals, which often have a recessive mutation (Smallcombe, 1949), could be the result of a small gene pool and inbreeding which can cause population decline or eventual loss (Charlesworth & Charlesworth, 1987).

Thanks to Victoria Muir and to an anonymous reviewer who provided assistance and commentary on this manuscript, respectively.

Fig. 2. The amelanistic common frog (*Rana temporaria*) spawn maintained at the author's home eight days after removal from the wild, when they had reached Gosner stages 14 and 15, showing the "neural fold" or "rotation". (Photo: E. Paterson)

Fig. 3. The amelanistic common frog (*Rana temporaria*) larvae had become darker in colour by day 19 when they had reached Gosner stage 23. (Photo: E. Paterson)

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Millport's Easter Class, 1939

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Some years ago I published a photograph of a teacher-training course in marine zoology held at Millport in 1914 (Moore, 2012). Recently an interesting series of Marine Station class photographs from 1939 came to my attention. At the recent members' evening of Cumbrae Historical Society, a member (Mrs Sue Forrest) exhibited (*inter alia*) eight snapshots taken that year and she kindly agreed to loan them to me to see what historical information I might glean from them. Three were identified on the reverse, as "Mar '39" and relate mainly to the Easter zoology class held at the Marine Station that year. Two, however, were identified as "Nov. '39" and the remainder simply as "Millport '39", one of which had the locality noted as "Fairlie Sands". All were annotated in ink by the same hand.

In the Annual Report of the Scottish Marine Biological Association for 1938–39 (SMBA, 1939) we read the following: "From 23rd–30th March Mr C.W. Parsons conducted the junior Easter class with the assistance of Dr J.D. Robertson. This class was a large one of 30 students from the University of Glasgow [possibly a second-year group: Roger Downie, pers. comm.], three from Cambridge and one from Aberdeen." (see Figs. 1-3). It may be a forlorn hope to expect to be able to identify the students, but I am confident that the man in the front row (slightly right of centre) in the somewhat faded Fig. 1, labelled on the reverse "Millport Zoology Class outside Marine Station, Mar. 1939", is the genial Richard Elmhirst (see Moore, 2008), the Station's Director who always took a prominent role in teaching student groups. It seems likely that the gentleman sitting cross-legged to his right is Charles Wynford Parsons. Parsons, a staff member of the Department of Zoology, University of Glasgow, was a vertebrate specialist; he wrote on the South American toad (*Ceratophrys*) (Parsons, 1932a) and penned the report on penguin embryos collected during the research cruises of RSS *Discovery* (Parsons, 1932b). Fig. 2 is captioned "Dr Robertson and 2 students". They are seen larking about on one of Millport's piers (Keppel? Millport Old Pier?), perhaps waiting for a boat or ferry trip. James Duncan ("J.D." to all) Robertson (1912–1993), who eventually became a Professor in the University of Glasgow, was a distinguished physiologist, with a particular interest in the inorganic composition of body fluids of marine invertebrates. He also worked on vertebrates and had an influential theory on the origin of vertebrates based on this work (Robertson, 1957). Fig. 3 captures a subset of the same group relaxing at the foot of the Deil's Dyke at the rear of the Marine Station. It is interesting to observe the formal outdoor attire of male students at the time: gabardine mackintoshes and trilby hats (see Fig. 2), and to note ruefully that their world was shortly about to be turned upside down by the outbreak of hostilities with Germany.

Fig. 1. "Millport Zoology Class outside Marine Station, Mar. 1939". (Photo: S. Forrest)

Fig. 2. "Millport March 1939 Dr Robertson & 2 students". (Photo: S. Forrest)

Fig. 3. “Millport Mar. '39”. (Photo: S. Forrest)

Fig. 4 is inscribed on the reverse “Millport, Dr Colson & students Nov '39” and looks as if they were just arriving by steamer. I can find no information relating to this party in the Annual Report of the Scottish Marine Biological Assoeiation for 1938–39 or 1939–1940 (SMBA, 1939, 1940). She may be Dr Barbara Colson who was a botanist (fungal cytologist), latterly of the University of Manchester.

Fig. 4. “Millport Dr Colson & students Nov. '39”. (Photo: S. Forrest)

ACKNOWLEDGEMENTS
I am grateful to Sue Forrest for allowing me aecess to her "Old Millport" photograph collection, and to Professor Roger Downie for his helpful comments.

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A book of ferns, Arran, June 1858

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The author purchased from a Glasgow-based antiquarian book dealer a bespoke elephant folio size herbarium album with specimens collected from June 1858 to at least February 1861. This comprises ninety-six pages with over one hundred and sixty pressed ferns from Scotland, Wales, England, the West Indies, Jamaica, South America, China, Japan, Norfolk Island, Australia, Tasmania, New Zealand, and Madagascar. The heavy paper sheets have glued-on acid-free tissue paper, and the whole is bound into a red decorated album with half leather and half calico covering and with a richly marbled inside board and first page. The album cover has "BRITISH FERNS" embossed centrally on the cover in gold lettering (Fig. 1), and a bookshop label records that it was made by Robert Forrester based in Stockwell Street, Glasgow. The eollector is not identified apart from being a resident on the Isle of Arran in June 1858. The only named person is a "Stephen Powell Esq.", who receives several acknowledgements, and who supplied various specimens from Australia and New Zealand, indicating that the album’s creator either corresponded with others, travelled widely or both.

The ferns appear to be displayed in the order in which they were personally eollected or obtained, regardless of the country of origin, classification relationships, etc., and they are identified via a mixture of attached printed labels, copperplate writing, pencilled annotations and a few hastily written temporary labels attached to the pressed plants themselves (Fig. 2A-D). The capitalisation eonvention is not always used for genus and species names, and spelling errors are present, suggesting that the collector was an untrained amateur. Dates and locations are very rarely or imprecisely recorded and the rarity status of specimens is provided on only a few occasions. The identifying characteristics are, however, well represented on the sheets and the specimens are well prepared and firmly attached with thin glued paper strips. Species collected on Arran dominate at first, those from mainland sites follow, such as green spleenwort (*Asplenium viride*) from Dunoon in September 1859 (Fig. 2A), and later a random mixture of British and foreign specimens is present. Attached sheets of eourse restrict the ability to organise a collection made over time.

Fig. 1. Front cover of the book of ferns. (Photo: R.S.L. Griffith)

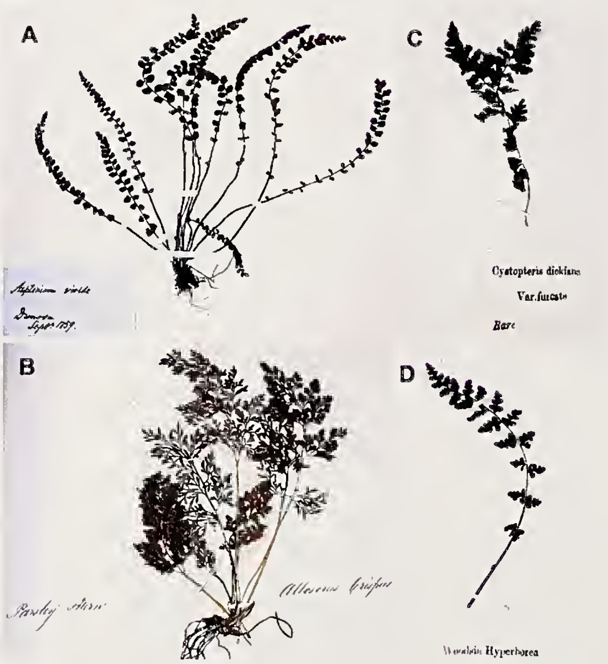

Fig. 2. A selection of specimens from the book of ferns. (A) Green spleenwort *Asplenium viride*, Dunoon, 1859. (B) Parsley fern *Cryptogamma crispa*. (C) Dickie's bladder fern *Cystopteris dickieana* var. *furcata*. (D) Alpine woodsia *Woodsia alpina*, Ben Lawers. (Photos: R.S.L. Griffith)

A significant number of visually impressive foreign ferns are present and a good representative selection of British species, including the filmy ferns and two species which are now considered extinct in Britain, namely the alpine bladder fern (*Cystopteris alpina*), only ever known from a site in Upper Teesdale, England and extinct since 1911, and the fountain spleenwort (*Asplenium fontanum*), once oceurring at several sites. A furcate and a normal specimen of Dickie's bladder fern (*Cystopteris dickieana*) are present, now known only from several cave sites near Aberdeen (Fig. 2C). A number of depauperate, furcate speeimens and other sports or varieties of British species are present and, as would be expected, many of the speeies are given eommon names and/or binomials that are no longer officially recognised, such as "Bree's fern", which was labelled "*Lophodium foenisecii*", i.e. hay-scented buckler fern (*Dryopteris aemula*). Some pages carry two or more different unrelated species, several duplicates are present, and some ferns are not identified. A few club mosses are included, such as *Selaginella umbrosa*.

Hennedy's *Clydesdale Flora* (Hennedy, 1865) illustrates how much easier it was for Victorian collectors to find what are now uncommon, rare or locally extinct species in the Scottish context, due initially to the effects of pteridomania as exemplified by this colleetion. The effect was even greater on rare varieties of rare species. For example, eventually the whole of the original colony of the furcate variety of Dickie's bladder fern was collected to extinction. Alpine woodsia (*Woodsia alpina*) (Fig. 2D), was avidly collected and it has as a result vanished altogether from two hectads near Crianlarieh. Famously, an attempt in Wales to acquire this plant for a collector led to the death in 1861 of William Williams, a renowned Snowdonia mountain guide. Oblong woodsia (*Woodsia ilvensis*), has likewise been lost from a hectad in the Moffat Hills, its only location in the Scottish lowlands.

The last dated specimen in the collection is from February 1861, a number of identified and pressed specimens were not mounted, and nearly forty pages remain blank suggesting a sudden termination of collecting. The robust album is in good condition despite showing signs of frequent use. The collector was clearly a dedicated enthusiast who sought rare speeimens and had contaets with other collectors. However, the lack of a progression towards seientific methodology suggests this individual was neither a member of learned natural history societies nor keen to eontribute scientific information in the form of species records, etc.

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Defensive behaviour in the scotch argus *Erebia aethiops* (Lepidoptera: Nymphalidae)

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Animals perform a huge variety of defensive behaviours when disturbed by predators and other agents. One type that has a wide taxonomic distribution is the passive dropping response, whereby a sudden and rapid descent is effected under the force of gravity alone. Perhaps the best-known example of this is shown by flying noctuid and geometrid moths, which close their wings and go into "free-fall" when they detect ultrasound patterns characteristic of closely approaching bats (Nakano & Mason, 2018). Whilst dropping responses are employed by animals as diverse as brittlestars (Echinodermata: Ophiuroidea) (Emson & Wilkie, 1982) and young gazelles (Mammalia: Bovidae) (Walther, 1969), they are particularly prevalent amongst terrestrial arthropods. They have been observed in arachnids, including spiders (Tolbert, 1975) and an acarid, the sheep tick *Ixodes ricinus* (I.C. Wilkie, pers. obs.), and in a range of insects other than moths, including aphids (Hemiptera) (Harrison & Preisser, 2016), bush crickets (Orthoptera) (Libersat & Hoy, 1991), and lacewings (Neuroptera) (Miller, 1984). In many of these cases, the dropping response is displayed by animals that are initially attached to a substrate (e.g. a silk web or vegetation) and therefore, of necessity, it is preceded by the animal releasing its grip. The present contribution provides information on a dropping response of this type, which was observed in a familiar butterfly and which appears not to have been previously described.

The scotch argus *Erebia aethiops* (Esper, 1777) (Fig. 1A) is widespread and locally abundant over sheltered, moist grasslands in Scotland, with only two colonies occurring further south in England in the Lake District (Thomas & Lewington, 2016). Since the 1970s it has shown "a modest decrease in occurrence and a significant increase in abundance" (Fox *et al.*, 2015) and is therefore, in terms of conservation concerns, regarded as being of low priority.

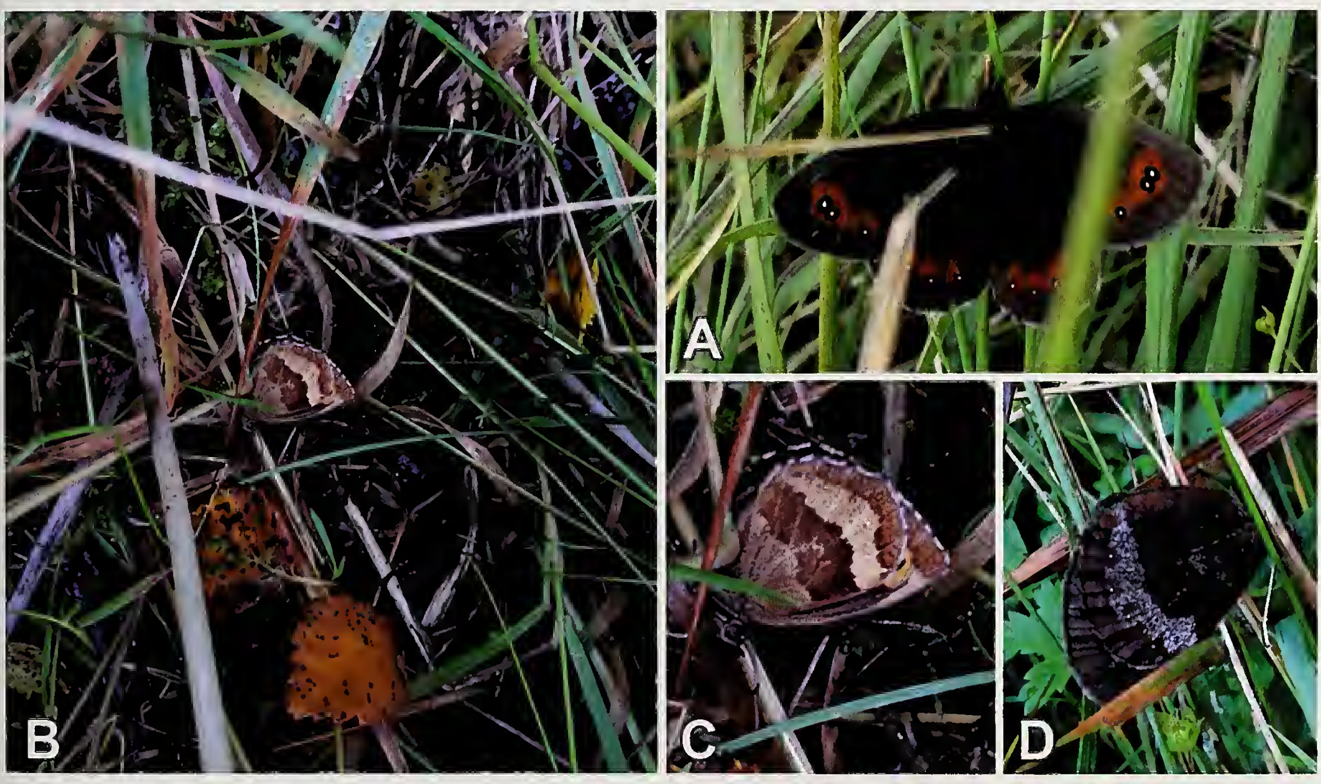

Fig. 1. Scotch argus (*Erebia aethiops*), Argyll, Scotland, August 2018. (A) Dorsal view of a resting individual, Creagan an Eich, Strachur. (B, C) Female, photographed immediately after completing the dropping response. Note the shed birch leaves. (D) Male, photographed immediately after completing the dropping response. (Photos: I.C. Wilkie)

On 7th August 2018 on the southwestern slope of Creagan an Eich near Strachur, Argyll (VC98) at an elevation of around 130 m, I saw a female scotch argus resting with open wings amongst long grass in an exposed situation just above a secondary birch wood (*Betula pubescens*). Although on sunny days these are very active butterflies and difficult to approach closely, this was a dull day and the insect did not at first react as I moved towards it. Eventually, however, when I disturbed the nearby vegetation it suddenly closed its wings and dropped down through the grass, settling on one side and remaining motionless with the visible hindwing almost completely overlapping the forewing and concealing most of the eyespot on the latter (Fig. 1B,C). After a few seconds it became active again, righting itself and crawling with closed wings over the grass leaves. I then deliberately agitated the vegetation near it again and it responded as before, falling onto one side and remaining motionless with overlapping wings (the eyespot on the forewing being completely concealed this time). When it righted itself and started to move, I repeated the exercise once more, producing the same result. On a subsequent dull day - 16th August 2018 - at a nearby location, I elicited the same response from a resting male scotch argus, which, when disturbed, fell on one side and remained motionless with closed wings (Fig. 1D). It is therefore likely that landing on one side is not accidental but an integral component of the defensive response.

Assuming that the primary function of this behaviour is predator avoidance, it would be especially effective in this particular location and at this particular time of the year, because the nearby birch trees had started to shed leaves. The colours of the undersurfaces of the butterflies' wings were within the range of colours shown by shed birch leaves, and the size (i.e. planar dimensions) of the closed wings was within the range of sizes shown by the birch leaves. The resemblance between the underside of the wings of this species and dead leaves has been previously noted (Haggart, 1895). Predator avoidanee in the scotch argus thus appears to comprise five components: detachment from the substrate, passive dropping, settling on one side, immobilisation, and leaf-masquerading ("masquerading" being defined as "resembling an inedible or unexciting object": Stoddard, 2012). As this has been inferred from observations on only two individuals, it of eourse requires corroboration.

It is unlikely that this pattern of defensive behaviour, if verified, would be unique to the scotch argus. The first two components of the adult behaviour are also shown by scotch argus caterpillars (Haggart, 1895), and by the caterpillars of other species with leaf-like camouflage, such as the grayling (*Hipparchia semele*) and meadow brown (*Maniola jurtina*) (Thomas & Lewington, 2016). It would be interesting to know if the adults of any of these other species also employ a dropping response.

Active scotch argus have been described as "diving for cover as soon as the sun becomes obscured..." (Emmet & Heath, 1990). This behaviour must be invoked by visual or thermal stimuli. In contrast, it is not known if the putative dropping response is triggered by mechanical or visual signals associated with agitated vegetation, nor if agitation characteristic of approaching predators can be distinguished from that due to abiotic factors, such as wind and rain.

I am grateful to Tony Payne and an external reviewer for drawing my attention to relevant literature.

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The caddisfly *Adicella filicornis* (Trichoptera: Leptoceridae) in Scotland

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The caddisfly *Adicella filicornis* (Pictet, 1834) is associated with very small trickles or seepages of water, close to their origin from groundwater springs. These habitats typically have an unstable bed and are almost always in areas with steep slopes. It was first discovered in Great Britain by Kenneth Morton during an excursion to Cleghorn Glen near Lanark, South Lanarkshire with the Glasgow Natural History Society in June 1883 (Morton, 1884), and to date this remains the only Scottish site for this species, with only five other extant populations in South Devon, Monmouthshire, Merionethshire, Denbighshire (Wallace, 2016), and Yorkshire where it was recently rediscovered by Andrew Dixon. Wallace (1976) rediscovered *A. filicornis* at Cleghorn Glen in February 1971 by searching for larvae in the type of habitat described by Morton. However, searches in 2012 did not find the species (Kirkland *et al.*, 2012).

Cleghorn Glen is an area of ancient woodland in a gorge formed by the Mouse Water, a tributary of the River Clyde. The underlying geology is limestone with old red sandstone. The slopes of the gorge are dominated by mixed ash woodland comprising ash, elm, sycamore and hazel, with alder in wetter areas. Several watercourses flow from the north down the slope of the gorge to join the Mouse Water. An area of groundwater seepage in Cleghorn Glen at NS8976545713 was visited on the 29th August 2018 to determine whether *A. filicornis* was still present. The seepage was in a small clearing and measured approximately 15 m x 5 m. Abundant creeping buttercup (*Ranunculus repens*) was present across the seepage together with smaller patches of silverweed (*Argentina anserina*). Adult caddisflies were collected by sweeping vegetation and larvae were collected by scooping small quantities of silt into a tub and using a "panning" action to reveal heavier caddis larvae and their cases.

Eight species of caddisfly and one species of stonefly were recorded. A single larval specimen of *A. filicornis* (Fig. 1) was collected from the outflow of the seepage, together with three other caddisfly species and a stonefly associated with springs and trickles: *Crunoecia irrorata* (Curtis, 1834), *Beraea maurus* (Curtis, 1834), *Wormaldia occipitalis* (Pictet, 1834), and the stonefly *Nemurella pictetii* (Klapálek, 1900). Also present were larvae of *Lepidostoma hirtum* (Fabricius, 1775), *Hydropsyche siltalai* Doehler, 1963, *Potamophylax latipennis* (Curtis, 1834), and *Plectrocnemia conspersa* (Curtis, 1834). Two adults of *Diplectrona felix* McLachlan, 1878 were collected close to the seepage, although no larvae were collected.

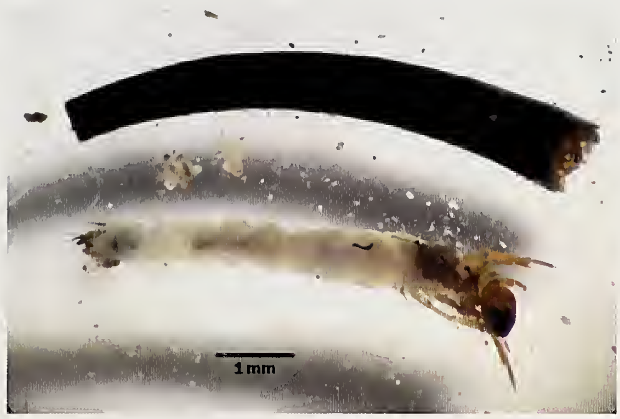

Fig. 1. Larva and case of the caddisfly *Adicella filicornis* found at Cleghorn Glen near Lanark, South Lanarkshire, Scotland on 29th August 2018. (Photo: C.R. Macadam)

This survey has confirmed the continued presence of *A. filicornis* at its only Scottish site. The area occupied in Cleghorn Glen is very small and as a result this population could be at risk from damage to the physical habitat where it lives. Future management of the site should avoid any changes to the habitat and conditions in the area. There are a number of other wooded gorges in the Clyde Valley, for example Nethan Gorge, Garrion Gill, and around the Falls of Clyde, that should be searched for this species.

ACKNOWLEDGEMENT

The authors would like to thank Kerry Wallace from Scottish Natural Heritage for permission to sample the site.

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Potential risk of American mink to water vole populations in east Glasgow

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Water voles (*Arvicola amphibius*) have undergone a rapid decline in the U.K. over the last few decades, due in part to the high predation pressure from introduced American mink (*Neovison vison*) (hereafter "mink") (Strachan, 2011). The water vole population within the Greater Easterhouse area of Glasgow was recently found to be of national importance, since this area contains some sites with the highest densities of water voles recorded within the U.K. (Stewart *et al.*, 2017, 2019). Although these populations are fossorial in dry grassland, the extensive network of watercourses within the Greater Glasgow area (Fig. 1) and the proximity to the Seven Lochs Wetland Park may make these populations potentially at risk from mink invasion.

Mink are distributed throughout the Greater Glasgow area (64 identified reeords) with the highest frequency of reports on the River Kelvin and the Forth and Clyde Canal, based on 1997-2017 records (Glasgow Museum Biological Record Centre, 2018; National Biodiversity Network Atlas, 2018). Interestingly, there seems to be few records of mink within the east of Glasgow (Fig. 1). This could be due to either the unsuitability of habitat for mink establishment or a lack of recording effort within the area. Mink could potentially access the fossorial water vole populations through the Luggie Water. This watercourse is directly connected to the River Kelvin and the Forth and Clyde Canal and linked to the Seven Lochs Wetland Park through the Bothlin Burn, therefore potentially serving as a corridor for mink (Fig. 2). Indeed, there was a recent sighting of mink on Johnston Loch, Garteosh, in September 2014 (R.A. Stewart, unpublished data), which suggests that they are already present within the area.

Mink generally settle in close proximity to water, as their feeding habits and protection from predators depend on these habitat features (Gerell, 1970; Yamaguchi *et al.*, 2003; Macpherson & Bright, 2010; Ahlers *et al.*, 2016). When settled in their territories, these predators generally forage within 10-50 m of streams (Macpherson & Bright, 2010), but they can also forage up to 500 m from a watercourse if suitable foraging opportunities exist (Gerell, 1970; Yamaguchi *et al.*, 2003). Additionally, mink can disperse across great distances overland between catehments, with one study reporting a mean dispersal distance in north east Scotland of 37.1 km (Melero *et al.*, 2017). This highlights their potential ability to colonise grassland where fossorial water vole populations may be found.

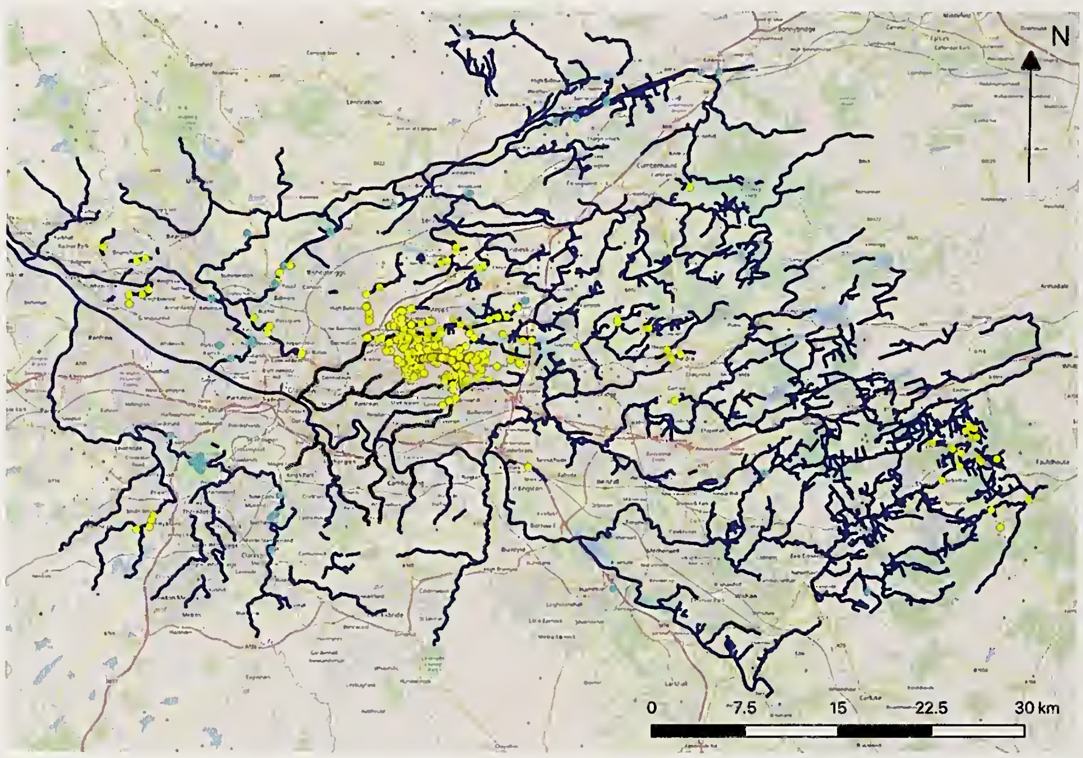

Fig. 1. Map of Greater Glasgow showing above-ground watercourses (blue) and underground watercourses (black). Water vole records 1994-2017 (yellow circles) and American mink records 1997-2017 (light blue circles) are plotted.

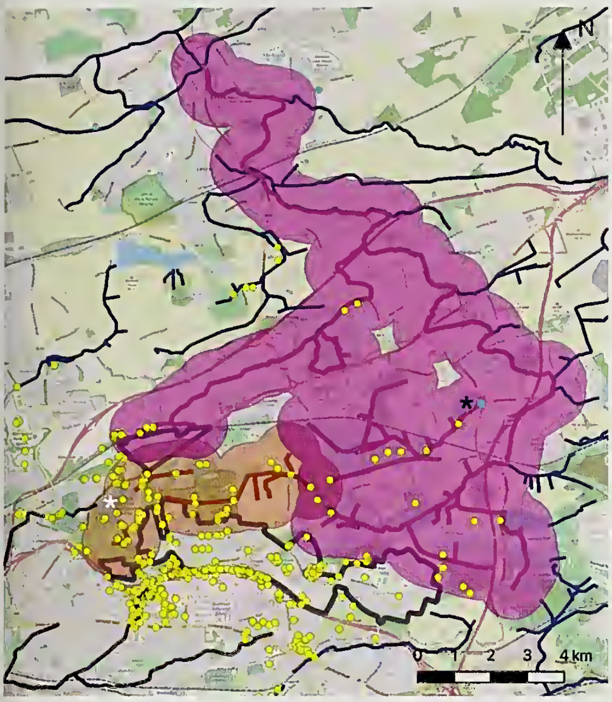

Fig. 2. Map of the east of Glasgow showing the records of American mink (light blue circles) and water voles (yellow circles). The 500 m zone surrounding the mink corridor (purple) represents the current potential distribution of mink. The 500 m zone (orange) represents the future potential distribution of mink around Hogganfield Loch and its tributaries (shown as orange lines). An urban land cover (buildings, parking lots, roads, maintained lawns and railroads) of over 80% is found within the thick grey margin in the bottom. Above-ground watercourses (blue) and underground watercourses (black). White asterisk: Hogganfield Loch; black asterisk: Johnston Loch.

In the light of the above, we attempted to identify the potential risk to fossorial water vole populations from current and future mink establishment in riparian habitats in the Greater Easterhouse area. This was undertaken by identifying fixed distance zones 50 m and 500 m around the putative mink corridor (Luggie Water and Bothlin Burn) using an open source geographic information system (QGIS Version 2.18) (Fig. 2) and plotting the number of water vole records (Glasgow Museum Biological Record Centre, 2018) within these zones obtained through a mix of opportunistic and systematic records of East Glasgow surveys (Table 1). This study assumed that the overlap between the potential mink distribution and the water voles could negatively affect water vole populations, as previously seen in linear riparian populations (Strachan, 2011). For the purposes of this study we use "record" to represent sites occupied by water voles. This analysis identified 27 water vole records that currently potentially face low risk from mink (between 50 and 500 m from a watercourse) and 11 records potentially facing high risk (between 0 and 50 m from a watercourse), representing respectively 4.3% and 1.8% of the total number of identified records (627) in the Greater Easterhouse area. Notably, if mink were to reach Hogganfield Loch (Table 1) and its associated tributaries, the number of records potentially at risk would increase considerably with low risk from mink increasing to 11.6% and high risk to 6.9% of records. Fortuitously, the built environment in Glasgow may reduce the risk of mink predation, as areas with more than 80% urban land cover have been found elsewhere to act as a barrier to mink dispersal (Ahlers *et al.*, 2016). However, given the history of establishment of mink within the U.K., mink have a high capability of dispersal and are likely to be more tolerant of human landscapes than was found in this recent study.

As water voles are protected under Schedule 5 (Section 9) of the Wildlife and Countryside Act 1981 (Strachan *et al.*, 2011), it is important to conserve populations. Hogganfield Loch is currently a relocation site for water voles affected by urban developments and therefore it is crucial to determine whether or not mink are found within this area. We would recommend the implementation of a monitoring scheme using rafts to detect mink occupancy in this particular site (Reynolds *et al.*, 2004), and would encourage local communities and naturalists throughout Glasgow to report sightings of mink for the benefit of this nationally important water vole population.

	Current potential risk		**Future potential risk**	
	Low	**High**	**Low**	**High**
Number of records	27	11	46	32
Percentage of records	4.3	1.8	7.3	5.1

Table 1. Current number of water vole records (representing occupied sites in the Greater Easterhouse Area, Glasgow) that are potentially at risk and future records (in the same sense) that could potentially be at risk from American mink predation if mink reached Hogganfield Loch and its associated tributaries. High risk corresponds to records found within 50 m and low risk to records found within 500 m of a watercourse. The total number of water vole records and mink records was 627 and 64 respectively.

ACKNOWLEDGEMENTS
We thank Richard Weddle from the Glasgow Natural History Society and Riehard Sutcliffe from Glasgow Museums Biological Records Centre for providing us with records for mink and water voles. The work was funded by the Seven Lochs Wetland Park (Heritage Lottery Fund), Scottish Natural Heritage, Glasgow City Council and the People's Trust for Endangered Species. Thanks to Professor Xavier Lambin for very helpful review comments.

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The caddisfly *Ylodes simulans* (Trichoptera: Leptoceridae) in Scotland

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The caddisfly *Ylodes simulans* (Tjeder, 1929) is known from a single watercourse in Scotland: the River Forth in Stirlingshire, and has been found in only four other rivers in the U.K.: the River Teifi, River Dee, and Western Cleddau in Wales, and the De Lank River in Cornwall, England. It was first collected at Aberfoyle by William Evans in July 1906 (Morton, 1906). Wallace (1976) found it at three sites on the River Forth in June 1972:

Site 1 - immediately upstream of Aberfoyle (NN528010).
Site 2 - Kirkton upstream of Aberfoyle (NN515009).
Site 3 - Cardross near Arnprior (NS599973).

At all sites *Y. simulans* was found predominantly on beds of *Myriophyllum* sp. (Ian Wallace, pers. comm.).

The sites where *Y. simulans* had previously been recorded were visited on 24th May 2017 (Site 3 only) and 30th July 2018 (Site 1 and Site 2) when mature larvae should be present. A fourth site, on the Goodie Water downstream of the Lake of Menteith (NS596996), was also visited in 2018 as it was known to have extensive beds of *Myriophyllum*. Samples of the freshwater macro-invertebrates present were collected with a standard pond net (0.25 m x 0.25 m frame; 1 mm mesh net). In addition, beds of *Myriophyllum* were searched for Leptoceridae larvae. Adult caddisflies were collected in July 2018 at Site 2 by sweeping vegetation with an entomological sweep net and light trapping using a bucket light trap with a 230 mm 6 watt actinic tube, and a 600 mm 18 watt actinic tube in front of a 1 m x 1.5 m white sheet stretched between two poles.

On 30th July 2018 Site 1 and Site 2 upstream of Aberfoyle were visited. However, very little *Myriophyllum* was found and this took the form of only short (*ca.* 5 cm) stems without any of the trailing stems charaeteristie of this speeies. Kick sampling, vegetation sweeping and light trapping failed to produce any specimens of *Y. simulans*.

At Site 3 at Cardross in May 2017 extensive beds of *Myriophyllum* were present. However, extensive searching did not find any specimens of *Y. simulans*. In July 2018 the river at Cardross was too high to sample, although it appeared that the extensive beds of *Myriophyllum* found in May 2017 were no longer present.

At the fourth site on the Goodie Water there were extensive beds of *Myriophyllum*. Kick sampling, searching weed beds, and sweeping bankside vegetation failed to produce any specimens of *Y. simulans*.

The apparent loss of *Y. simulans* from the River Forth is concerning. The cause of this loss is unknown. However, the absence of large beds of *Myriophyllum* in the main river is likely to be a contributing factor. It is hoped that a remnant population is still present and further searches should be undertaken in the Forth catchment where *Myriophyllum* is found.

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The mayfly *Baetis digitatus* (Bengtsson, 1912) (Ephemeroptera: Baetidae) in Scotland

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The scarce iron blue mayfly (*Baetis digitatus* Bengtsson, 1912) was first recorded in Great Britain from the East Stoke millstream on the River Frome in Dorset (Müller-Liebenau, 1969; Crisp & Gledhill, 1970; Kimmins, 1972). Further records have been made since 1990 from Monmouthshire and Hampshire. However, there are historical records from Ceredigion, Powys, Devon, Hampshire and Herefordshire (Macadam, 2016). It was discovered in Scotland in the Lunan Burn near Blairgowrie in 1986 (Gunn & Wright, 1994) and this has remained the only Scottish location for this species to date.

Nymphs of this species inhabit riffle areas of rivers and streams where they can typically be found crawling amongst macrophytes, although they will swim in short, darting bursts if disturbed (Macadam & Bennett, 2010). There is one generation of this species per year, which overwinters as half-grown nymphs. There is little or no growth over the winter months with the remainder of their growth taking part in the spring (Söderström, 1991). The flight period extends from May to October (Elliott & Humpesch, 1983), with recent work showing that there may be two distinct peaks in the flight period – one in the spring and another in the autumn (C. Macadam, pers. obs.). This suggests that there may be two separate cohorts: a slow growing winter cohort and a much faster growing summer cohort.

The Lunan Burn rises to the north of Dunkeld at an altitude of 352 m and flows east to south-easterly for approximately 24 km to its confluence with the River Isla west of Coupar Angus. During its course the watercourse flows through five large lochs: Loch of Craiglush, Loch of the Lowes, Butterstone Loch, Loch of Clunie, and Marlee Loch. These lochs form the Dunkeld-Blairgowrie Lochs Special Area of Conservation which is designated principally for their oligotrophic to mesotrophic nature (Anon., 2018). The upper catchment of the Lunan Burn comprises mainly commercial conifer plantations and below Butterstone Loch the land use changes to arable agriculture. In 2012-13 a pair of Eurasian beavers (*Castor fiber*) established a lodge on the Lunan Burn to the south-east of Marlee Loch. Beavers have since established a number of dams which are likely to alter the hydrology of the watercourse (Campbell *et al.*, 2012).

The Lunan Burn immediately downstream of Marlee Loch (NO147433) was visited on 11th May 2018 to check the status of the population of *Baetis digitatus*. This river section was approximately 6 m wide with a water depth 0.2-0.4 m during the visit. The bed consisted predominantly of pebbles and the channel was heavily shaded by deciduous trees.

Samples of the freshwater macro-invertebrates were collected with a standard pond net (0.25 x 0.25 m frame, 1 mm net mesh). Numerous nymphs of *Baetis digitatus* were recorded, together with several adults, confirming the continued existence of the population discovered at this site in 1986. Further surveys are required to determine the extent of the population in the Lunan Burn catchment.

Two further Scottish populations of *Baetis digitatus* were discovered during surveys in Dumfries and Galloway in the Drumpail Burn upstream of Drumpail Bridge on the Glenluce to Tarf Bridge road on 16th July 2018, and in the Water of Malzie immediately downstream of Mochrum Loch (NX31015383) on 29th July 2018.

The Drumpail Burn rises on Artfield Fell at an altitude of 196 m above sea level, approximately 11 km north of Glenluce. It flows in a southerly direction before turning eastward to join the Tarf Water approximately 1 km south of Tarf Bridge. *Baetis digitatus* was found in a reach immediately upstream of the Drumpail Bridge on the Glenluce to Tarf Bridge road. The river here was approximately 1.5 m wide with a maximum depth of 0.3 m. Flow in this section was relatively swift and there were a few submerged macrophytes present. The bed consisted of stones and small boulders and the watercourse had an open aspect as it flowed through open moorland with scattered scrub.

The Water of Malzie is formed from the outflows of several interconnected lochs including Mochrum Loch, Castle Loch, Black Loch, Fell Loch and Loch Hempton in the area of the Moor of Drumwalt. The source rises at an altitude of 110 m around 1 km from the shore of the Solway Firth at Luce Bay. It flows north-easterly for approximately 13 km to its confluence with the River Bladnoch, upstream of Bladnoch. *Baetis digitatus* was found in a reach of the Water of Malzie close to the Old Place of Mochrum. The stream at this point was approximately 2 m wide with a maximum depth of 0.5 m. Flow in this section was slight and there were submerged and emergent macrophytes present. The bed consisted of organic material including peat and silt, with occasional pockets of small pebbles, and the banks were steep and faced with stonework. A number of bushes and small trees shaded parts of the watercourse, although the area where *B. digitatus* was collected had an open aspect.

The discovery of new populations of *B. digitatus* in Scotland was predicted by Gunn & Wright (1994). The similarities in habitat and appearance between nymphs and adults of *B. digitatus* and *B. niger* may have caused some past taxonomic confusion and the likelihood of further populations of *B. digitatus* being discovered in the future is high. Two of the known Scottish populations are found immediately downstream of the outflow of a loch, which suggests that it may be useful to search similar sites for this species.

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Nomada flava (Hymenoptera: Apidae): first confirmed Scottish record

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On 31st May 2018, after a tip-off from a local bird-watcher, I visited Carbarns (NS765542, Lanarkshire VC77) on the banks of the Clyde upstream of Baron's Haugh, to collect a specimen of a solitary bee that he had seen a few days before. His photograph was of a *Lasioglossum* species (indet.), but on my visit, after some searching, I found only bees belonging to the genus *Nomada*, one of which I collected for identification.

The bee turned out to be a female *Nomada flava* Panzer, 1798, a cuckoo-bee that lays its eggs in nests of *Andrena* species (mining bees). Because the previously known range of *N. flava* extended northwards only as far as Durham and Cumbria (Else & Edwards, 2018), it was necessary to have the identity confirmed by an expert (Murdo Macdonald) who also drew my attention to an account of an earlier 1894 record from the shores of the Cromarty Firth; the 1894 specimens, though conforming to the description of *N. flava* and within the range of the principal host species *Andrena scotica*, were found in September, outside the usual flight period of March to June, and were therefore "difficult to interpret" (Else & Edwards, 2018).

I intend to pay another visit to the site in the hope of finding possible host species; on my first visit nesting burrows were evident in the sandy bank, and bee-flies (*Bombylius major*), another kleptoparasite of solitary bees, were seen there on the same day that the *Lasioglossum* specimen was observed.

I am grateful to Davie Abraham for drawing my attention to the *Lasioglossum* bees and the bee-flies, and

to Murdo Macdonald for confirming the identities of the *Nomada* and *Lasioglossum* specimens.

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A new Scottish record of the stonefly *Amphinemura standfussi* (Ris, 1902) (Plecoptera: Nemouridae)

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The stonefly *Amphinemura standfussi* (Ris, 1902) is found throughout Great Britain. However, it tends to have a very localised distribution (Macadam, 2015). Although in Scotland nymphs of this species have been reported from Sutherland to Berwickshire, there have only been 16 records in the past 35 years (Table 1).

This species appears to prefer first order streams, particularly small grassy trickles, but it may also be found in larger watercourses towards the middle river (Langford & Bray, 1969). It is typically found in areas of slow flow, and in headwaters it may occur in very slow flowing trickles and seepages (A. Dixon, pers. obs.). It favours fine substrates such as silt, and in upland areas peat, partieularly where there is coarse particulate organic matter present such as dead leaves or thatch (Hynes, 1941). The preference of this species for small headwater streams may explain the lack of records, as few studies have been undertaken of these habitats (Maitland, 1999).

A targeted survey for *A. standfussi* was made of small first order streams in the catchment of the River Carron in Stirlingshire. An extended period of warm dry weather in June and July 2018 meant that any streams that continued to flow could be eonsidered perennial and more likely to yield specimens of *A. standfussi*. Three sites were sampled on the 27th August 2018:

Site 1 - unnamed burn near Easter Cringate Cottage (NS720875).
Site 2 - unnamed burn at Easter Cringate (NS704869).
Site 3 - River Carron at its source near Muir Toll (NS631819).

At each of these sites the watercourse was 0.15-0.30 m wide and hidden by riparian vegetation, typically rushes (*Juncus* spp.) and purple moor grass (*Molinia caerulea*). Adult stoneflies were collected by sweeping vegetation adjacent to the watercourse with an entomological sweep net. Searches typically extended 2-3 m either side of the watercourse. All stoneflies collected were retained for identification.

Five species of stonefly were recorded during the surveys (Table 2). A single adult specimen of *A. standfussi* was recorded from the unnamed burn at Site 2. Further searches of this watercourse for the nymphs and more adults of *A. standfussi* were undertaken on the following day. However, no further specimens were found.

Date	Location	Grid Reference	Source
1959-61	Mary Glyn's Burn	NS681889	Maitland (1966)
1959-61	Endrick Water at Burnfoot	NS681889	Maitland (1966)
<1983	River Forth at Drip Bridge	NS770955	Bird (1983)
03/08/1986	Burn of Latheronwheel	ND176367	River Macrophytes Database
19/10/1986	Burn of Latheronwheel	ND188389	River Macrophytes Database
15/10/1989	Black Water	NC747161	River Macrophytes Database
23/08/1990	Blackadder Water	NT694473	River Macrophytes Database
12/11/1990	Blackadder Water	NT623527	River Macrophytes Database
08/04/1997	River Devon at Blacklinn	NN992049	Scottish Environment Protection Ageney
27/05/1997	River Forth at Cobleland	NS532987	Scottish Environment Protection Agency
15/04/1998	River Forth at Cobleland	NS532987	Scottish Environment Protection Agency
17/04/1998	Goodie Water downstream of B8034 Road Bridge	NS595996	Scottish Environment Protection Agency
21/04/1998	Duchray Water upstream of River Forth	NS506013	Scottish Environment Protection Agency
26/04/2005	River Forth at Cobleland	NS531986	Seottish Environment Proteetion Agency
26/04/2006	River Forth at Cobleland	NS531986	Scottish Environment Proteetion Agency
15/05/2007	River Moriston at Torgyle Bridge	NH309130	Scottish Environment Protection Agency

Table 1. Scottish records of *Amphinemura standfussi.*

Speeies	Site 1 NS720875	Site 2 NS704869	Site 3 NS631819
Amphinemura standfussi (Ris, 1902)		*	
Isoperla grammatica (Poda, 1761)		*	
Leuctra fusca (Linnaeus, 1758)	*	*	
Nemoura cinerea (Retzius, 1783)		*	*
Nemurella pictetii Klapálek, 1900	*	*	

Table 2. Records of stoneflies (Plecoptera) found in the catchment of the River Carron, Stirlingshire, Scotland in 2018 during this study. Grid references are given, but the specific locations of sites are described in the main text.

It would appear that *A. standfussi* can occur in very low numbers where it is found. This may explain the paucity of records for this species, and the difficulty of finding it may account for the apparent disappearance of this species from the neighbouring Endrick Water catchment (Dodd, 2011). It is antieipated that further records of *A. standfussi* will be made in Scotland. Further surveys should be undertaken in small slow-flowing streams and trickles to help to fully determine the distribution of this species.

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Palloptera muliebris (Diptera: Pallopteridae): a rare Scottish occurrence

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On 15th September 2018, I came across a specimen of *Palloptera muliebris* (Harris, [1780]) in a covered stairway at High Street station, Glasgow (NS598651). The sinuous markings on the wings are distinetive, and the fly was displaying the "wing-waving" characteristic of members of the superfamily Tephritoidea.

This species (Fig. 1) seems to be rather rare in Scotland: there are no records north of Carlisle in the National Biodiversity Network (NBN) Atlas for the U.K. and Ireland (National Biodiversity Network, 2018), nor were any Scottish records known to the relevant national recording scheme (D. Clements, pers. comm.). However, there are records from Bridge of Allan (Rotheray & Lyszkowski, 2012) and subsequently from Dunblane (G.E. Rotheray, pers. eomm.; date not given).

Fig. 1. *Palloptera muliebris* (female). Scalebar = 5 mm. (Photo: S. Falk; all rights reserved; see Falk, 2018)

Often "new records" turn out to reflect under-recording rather than previous absence, in this case perhaps because the fly, although distinctive, is rather small, being about 5 mm in length (Fig. 1). Rotheray describes difficulties in capturing adult *Palloptera* species, however, which would suggest that they may be genuinely under-recorded (Rotheray, 2014). The question also arises as to why *P. muliebris* might appear indoors in central Glasgow. The larvae of *Palloptera* species are probably mostly saprophagous (Rotheray, 2014), and the larvae of *P. muliebris* have been reported in association with beetle larvae, possibly feeding on detritus in the beetle tunnels or under bark (Séguy, 1934), although it has also been suggested that they may actually be predatory on bark-beetle (Scolytidae) larvae themselves (Chandler, 1991). Adults of the species frequently occur indoors, however, where they may be feeding either on the detritus or larvae of carpet beetles (Dermestidae) (Jones, 2016; D. Clements, pers. comm.). There is a woodland strip along the railway east of High Street station, which might generate suitable substrates for saprophagous larval feeding. More likely scenarios include the possibility that larvae were imported with plant material used in landscaping a nearby building development - rosemary beetles *Chrysolina americana* (Chrysomelidae) occurred in an earlier planting there (pers. obs.) - or that the adult may simply have been blown in on the strong winds that had occurred shortly before the sighting.
The sighting is now on the NBN Atlas as the only Scottish record.

I am grateful to Geoff Hancock for verifying the identity of the specimen, to Graham Rotheray for details of the previous Scottish records, and to David Clements for background information. The specimen has been added to the Hunterian Museum collection.

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The powdercap strangler *Squamanita paradoxa*, a bizarre parasitic mushroom found for the first time in the Glasgow area

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The powdercap strangler *Squamanita paradoxa* belongs to a small genus of rather rare and enigmatic fungi. Although the genus has been known for nearly 80 years, its unusual morphology has caused a good deal of confusion and debate among mycologists. The strange chimera-like mixture of microscopical tissues suggested affinities to quite different fungal orders. While some authors had speculated that the unusual features may indicate that mycological parasitism was involved, it was only the examination of new material of *Squamanita contortipes,* from Washington State, U.S.A. in the 1990s, that enabled the mystery to be finally resolved (Redhead *et al*., 1994; Gee, 1995). It was confirmed that *Squamanita* species are parasites of other fungi, invading the emergent fruiting body of the host and supplanting it with their own fruiting body.

The advent of molecular analysis has since allowed the phylogeny of the genus to be elucidated (Matheny & Griffith, 2010). Only seven *Squamanita* species are known from Europe with four of these occurring in Britain (Henrici, 2013). The different species are usually associated with different host fungi, although *S. paradoxa* and a similar species, *S. pearsonii,* both infest the earthy powdercap, *Cystoderma amianthinum.* *S. paradoxa* is the most widespread British species, with around 25 U.K. sites, and with the first British record from Mull in 1969. Currently it is known from only three other Scottish locations: Aberdeenshire, 1999; Peebles, Scottish Borders, 2001; and Lochwinnoch, Renfrewshire, 1996 and 2013 (Silverside, 1998; Fungal Records Database of Britain and Ireland, 2019).

On 31st August 2017 during a fungal foray by J.M. at Cathkin Braes Country Park on the south-east side of Glasgow, two specimens of *S. paradoxa* were found on a strip of grass close to Queen Mary's Seat (NS61825856). No unparasitised *Cystoderma amianthinum* were observed. The only other fungi present on the grassy area were a few glutinous waxcap *Hygrocybe glutinipes* (var. *glutinipes*). The *S. paradoxa* were around 6 cm high with a cap diameter of around 4 cm. They were readily recognized, without the need for microscopical examination, as the stipe

showed the distinctive orange scaly *Cystoderma* base and the abrupt colour change to lilac-grey where the parasitic *Squamanita* takes over, as if grafted onto the *Cystoderma* stipe (Fig. 1). The site was revisited a year later on 29th August 2018. The grass strip then harboured quite a few brown mottlegill *Panaeolina foenisecii*, but despite an exhaustive seareh there was no sign of any further *S. paradoxa* or any other fungi.

Fig. 1. Powdercap strangler *Squamanita paradoxa* from Cathkin Braes Country Park, Glasgow, August 2017. (A) Specimen 1. (B) Specimen 2. (Photos: J. Mitchell)

The nearest previous *S. paradoxa* record is from Muirshiel Country Park, Lochwinnoch, where it was found in 1996 by Alan Silverside and again in 2013 during a survey by the Clyde and Argyll Fungus Group. The new find of *S. paradoxa* suggests that this and possibly other *Squamanita* speeies may be more widespread in Scotland.

All the *Squamanita* species are relatively small and only *S. paradoxa* appears in recent field guides (e.g. Sterry & Hughes, 2009; Buczacki *et al.*, 2012). Hence they are likely to be overlooked or unrecognised by all but the expert field mycologist. Detailed descriptions and a key for the British *Squamanita* species are provided by Watling & Turnbull (1998). The British speeies all have grey-violet caps. *S. contortipes* which infests *Galerina* spp., has been found only once in Britain, in 1950 at Rothiemurchus, Speyside (Henrici, 2013). *S. odorata*, which parasitises *Hebeloma* spp., has only recently been found for the first time in Britain, in 2010 in Nottinghamshire, England (Leach, 2013). *S. pearsonii*, which has been recorded from Speyside and Aberdeenshire (Holden, 2005) as well as Caernarvonshire, Wales, resembles *S. paradoxa* but can usually be distinguished in the field by its much shaggier stipe and cap (Holden, 2005; Argaud & Wiest, 2018). It is hoped that highlighting this new find might alert naturalists to look out for these rare and unusual parasitic fungi.

Roy Watling and Liz Holden kindly assisted with the preparation of this note.

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Woodlouse diversity on some Clyde Estuary islands

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Woodlice (Isopoda: Oniscidea) are ubiquitous in terrestrial habitats, and over 30 species are native or naturalised in the U.K. Throughout the summer of 2017 C.S.B. opportunistically searched extensively around the islands of Arran, Bute and (with the owner's permission) Pladda for woodlice.

At 432 km^2 Arran is the largest island in the Firth of Clyde, with a resident human population of around 4,600. Pladda is a very small (0.11 km^2) island 1 km to the south of Arran. It is uninhabited but has a lighthouse built in 1790 and staffed since then until it was automated in 1990. Bute (122 km^2) lies to the north of Arran, and is the most populous of the Firth of Clyde islands, with a resident human population of around 6,400. It is only 300 m from the mainland at its nearest point.

Three woodlice species were present on all three islands (see Table 1). The common shiny woodlouse (*Oniscus asellus*) was found at 49 locations on Arran, eight on Bute and six on Pladda. The common rough woodlouse (*Porcellio scaber*) was found at 52, five and five locations respectively. Finally, the common sea slater (*Ligia oceanica*) was found at four, one and four locations respectively.

In addition, two other species were found on Arran: the common striped woodlouse (*Philoscia muscorum*) at four locations, and the common pill woodlouse (*Armadillidium vulgare*) at two locations. This last species was also found at two locations on Bute. No other species were found on Pladda.

Previously, Gregory (2016) reported the following species found at one location on Arran in 2010: the common rough woodlouse, the rosy woodlouse (*Androniscus dentiger*), the common pygmy woodlouse (*Trichoniscus pusillus* agg.), and the ant woodlouse (*Platyarthrus hoffmannseggii*). The low overlap with this study speaks to the impressive diversity of woodlice within a small geographical area thanks to their variety of lifestyles and low dispersal ranges.

The common pill woodlouse was previously reported on Bute by Collis & Collis (2008).

Previous surveys on Bute in 1999 and 2003 (Collis & Collis 2004), did not find the common pill woodlouse but did report the other species we found plus the common pygmy woodlouse, rosy woodlouse, *Haplophthalmus mengii* (*sensu lato*), *T. pygmaeus*, and *Cylisticus convexus.* Had we surveyed in a more targeted fashion at a damper time of year, we would have expected to find some pygmy species: *T. pusillus* agg. and *T. pygmaeus* on at least the larger two islands, and perhaps *T. saeroeensis*, which has been found on the nearby mainland coast.

That tiny Pladda can support three (albeit common) species of woodlice speaks for their exceptional colonisation ability, often helped inadvertently by humans, and their population resilience once stabilised.

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	Oniscus asellus	*Porcellio scaber*	*Ligia oceanica*	*Armadillidium vulgare*	*Philoscia muscorum*
Bute	X	X	X	X	
Arran	X	X	X	X	X
Pladda	X	X	X		

Table 1: Summary of woodlouse species found on the three islands in the Clyde Estuary during 2017.

New records of the northern summer mayfly (*Siphlonurus alternatus* Say, 1824) in Scotland

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The northern summer mayfly (*Siphlonurus alternatus* Say, 1824) has always been a rare species. It was first recorded in Britain from the River Tummel, Perthshire in 1913 (Mosely, 1931). Subsequent records were made from Dumfries and Galloway (Macan, 1951) and the River Severn (Macan, 1979). The only verified modern records are from the River Dove catchment in the Peak District. However, there are a number of other unverified records of this species (Maeadam, 2016). Many of these other records elosely overlap with the range of other *Siphlonurus* species and in the absence of a voucher specimen these records remain unsubstantiated (Macadam, 2016).

Bratton (1990) noted that a lack of records of this species from the mainland British Isles did not necessarily indicate a "notable species". However, the paucity of records in the intervening period led Macadam (2016) to classify this species as "endangered". Recent recording activity has subsequently confirmed three new sites for this species in south west Scotland: the Drumpail Burn and Long Loch of the Dungeon (Dumfries and Galloway) and Loch Doon (Ayrshire). This now brings the total number of confirmed records from Great Britain to twelve (Table 1). Seven (58%) of these records are from south west Scotland, with a further three (25%) from the Peak Distriet. The remaining records are from the River Tummel in Perthshire and the River Severn in Worcestershire.

Nymphs of this species typieally live in deep pools in rivers and streams, but can also be found in ealcareous lakes (Kimmins, 1932; Bratton, 1990). The large nymphs are good swimmers and typically swim in short, darting bursts. They feed by gathering or collecting fine particulate organic detritus from the sediment. There is one generation a year, which usually overwinters as eggs and emerges between May and August (Elliott & Humpesch, 2010). Emergence of the adults typically takes place during daylight hours (Elliott & Humpesch, 1983) and males of this species can be found swarming at dawn and dusk over light patches of substrate on the bed of the water body or floating plants sueh water-lilies (Savolainen, 1978). It is anticipated that future surveys in south west Scotland will turn up further records of this species. All records reported in this note will be made available on the *NBN Atlas* as part of the Ephemeroptera Reeording Scheme dataset.

Date	Location	Grid reference	Recorder
<1951	River Cree	-	T.T. Macan
June 1913	River Tummel	-	M.E. Mosely
August 1949	Loch Trool	NX4179	T.T. Macan
2 July 1975	River Severn downstream of Dowles Brook	SO780764	Environment Agency
31 July 1986	River Cree at Cordorcan Burn	NX380709	Institute of Freshwater Ecology
22 June 2010	River Manifold downstream of Ludburn Farm	SK0946362957	N. Everall
7 September 2011	River Dove at Beresford Dale	SK1282358596	N. Everall
24 April 2013	Back Brook upstream of Upper Hulme	SK0141561893	N. Everall
2 May 2016	Loch Doon	NS478006	Marine Scotland
15 August 2016	Drumpail Burn	NX22026330	Envirocentre
10 June 2017	Long Loch of the Dungeon	NX468839	R. Merritt
16 July 2017	Drumpail Burn	NX223621 to NX223649	A. Farr

Table 1. Confirmed records of *Siphlonurus alternatus* in Great Britain.

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New records of coral fungi: upright coral *Ramaria stricta* and greening coral *Ramaria abietina* from central Scotland

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Coral fungi of the genus *Ramaria* form clumps of beautiful branching growths with a superficial resemblance to marine corals. There are around a dozen species in the British Isles, most of which are uncommon and seldom recorded (Buczacki *et al.*, 2012).

During a visit to the King's Buildings Campus, University of Edinburgh, on 24th November 2011 numerous clumps of coral fungi, each around 10 cm in diameter and height, were observed spread over just a few square metres of a woodchip mulched border bed, adjacent to the West Mains Road entrance (NT26537078). A specimen was collected and sent to Professor Roy Watling who confirmed the identity as the upright coral (*Ramaria stricta*). This site was revisited three years later on 21st October 2014, when around 25 similar clumps of *R. stricta* were observed and photographed in the same border bed (Fig. 1).

Fig. 1. Clumps of upright coral fungus (*Ramaria stricta*), King's Buildings Campus, University of Edinburgh, October 2014. (Photos: M. O'Reilly)

On the 23rd September 2017, during a Clyde and Argyll Fungus Group (CAFG) foray in Victoria Park, Glasgow, an array of *R. stricta* growths was discovered, also in woodchip mulched border shrubbery, close to the children's play area (NS54056728). Again numerous clumps of fungi were observed among the bushes, but some of these had amalgamated into a spectacular wavy stand around 1 m long, 20 cm wide, and 15 cm in height (Fig. 2). This site was revisited in 2018, but late in the season on 28th December, when about 20 clumps of remnants of *R. stricta* were found in various states of decay. In 2018 the coral fungi clumps were about 10 cm in diameter with only one double clump about 20 cm in length.

On 26th October 2016 a group of seven clumps of greening coral (*R. abietina*) were found growing among leaf litter under a Sawara cypress (*Chamaecyparis pisifera*) in the author's garden in Giffnock, Glasgow (NS55835902). *R. abietina* forms clumps around 3-5 cm in width and height. It has a distinct olive-green colouration but, despite this, is quite difficult to spot among leaf debris (Fig. 3).

Fig. 2. Upright coral fungus (*Ramaria stricta*), Victoria Park, Glasgow, September 2017. (A) Large growth around 1 m long. (B) Close-up of growth around 10-15cm high. (Photos: M. O'Reilly)

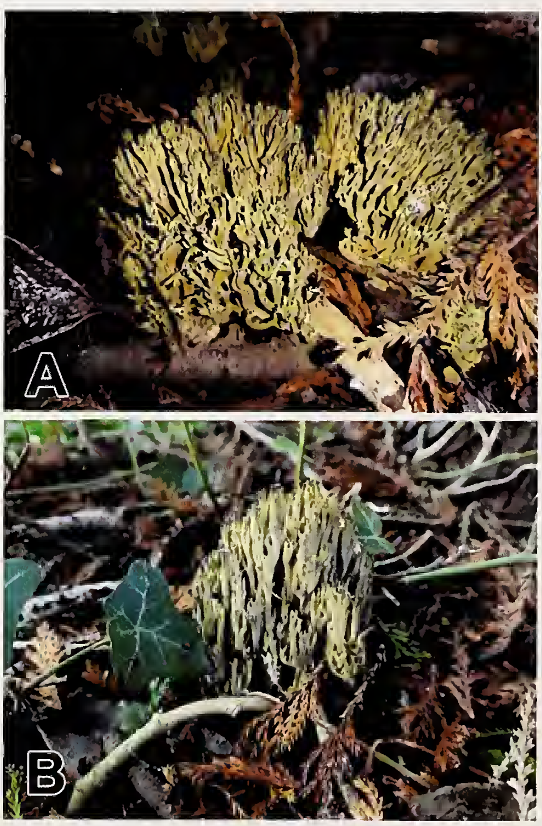

Fig. 3. Clumps of greening coral fungus (*Ramaria abietina*), around 5 cm high, on cypress leaf litter, Giffnock, Glasgow, October 2017. (Photos: M. O'Reilly)

Around ten clumps of *R. abietina* reappeared at the same location on 27th October 2017, and a single clump again on 17th November 2018. *R. abietina* material was also sent to Professor Roy Watling for confirmation.

The distributions of *R. stricta* and *R. abietina* in Scotland are quite similar, with most records in the north-east Highlands and just a couple each in southern Scotland (National Biodiversity Network, 2019). They are relatively uncommon with 14 and 32 Scottish records respectively shown on the National Biodiversity Network Atlas. However, the atlas shows relevant records only up to 2003/2004. The Fungal Records Database for Britain and Ireland (2019) holds more recent records, to October 2014 for *R. stricta* and October 2015 for *R. abietina*. For *R. stricta* the records from central Scotland include two from Glasgow (Blythswood Square, 2004; and Bell Street, Calton, 2011) and one from Chatelherault Country Park, Hamilton in 2010. For *R. abietina* the central Scotland records include Chatelherault (2004, 2005, and 2008), Edinburgh (Bawsinch, 2006), Lanark (2011), Kilsyth (Colzium Estate, 2011) and Glasgow (Bell Street, Calton, 2011). The site at Bell Street in Calton, Glasgow is of interest holding both species simultaneously. *R. stricta* occurs naturally on decaying wood but is known to thrive on mulched wood-chippings and might be expected to become more common with the increasing use of such mulches in suburban areas. *R. abietina* is associated with coniferous needle litter and many records originate from conifer plantations. However, exotic conifers in suburban areas offer an equally acceptable habitat. Hence both of these unusual species should be looked out for in suburban parks and gardens where they may be currently overlooked.

Thanks are due to Professor Roy Watling (Edinburgh Royal Botanic Gardens) for confirming the identifications.

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The Glasgow Naturalist (2019) Volume 27, Part 1, 97-99

BOOK REVIEWS

Ancient Oaks in the English Landscape

Aljos Farjon

Kew Publishing, Royal Botanic Gardens, Kew, 2017. 348 pages, hardback with many coloured plates as illustrations, tables and maps, some in black & white. ISBN 978-1-84246-640-7.

£30.00

The author, renowned for his work on eonifers, is a Dutch botanist who has turned his attention to the iconic tree of his adopted homeland. He does not address the systematics of oak (*Quercus*) species. For those seeking information about the differences between common (English) oak (*Q. robur*) and sessile oak (*Q. petraea*) this is not the book for them. The author makes clear early on that his intention is to treat them as one "oak" and to concentrate on how so many oaks in England have grown to such a large size and occupy such a wide area of the landscape. Eleven chapters deal with the oak life-cycle, the age of ancient oaks and their distribution in England and Europe, reasons for their numbers in England and their most important locations. There are also chapters on their biodiversity and conservation.

The importance of this book lies more than anything on the premise that more ancient oaks are to be found in England than in the rest of Europe put together: 115 living ancient oaks having a girth (eircumference) of >9 m are present in the former, and 96 in the rest of Europe. A chapter is devoted to ancient oaks in Europe and the reasons for England's pre-eminenee in terms of ancient oak numbers is investigated.

This is a thoroughly well researched book, based on the Ancient Tree Inventory of very old oaks in England. The author has visited all of the most important. He debates methods used to estimate a tree's age and concentrates on those having a girth of >6.00 m as, he argues, trees of that girth are likely to have existed since before 1603, the end of the Elizabethan era. So he has drawn up maps showing the location of these oaks and discusses the historical reasons for this distribution.

He investigates deer parks, both medieval and Tudor, as well as Royal forests and wooded commons. These different types of habitat are steeped in history that is quite fascinating. It is pointed out, for example, that many oaks have survived because they were used, not as sources of timber, but to provide shelter for deer, the hunting of which was a major preoccupation. Some 50% of ancient oaks owe their origin to medieval deer parks, very much a Norman creation, on land granted to many noblemen, with continuous ownership of conservation-minded gentry through to the present day, unlike the situation on the continent. The absence of wars and the availability of overseas timber are also major factors explaining the survival of these species.

For the chapter on the biodiversity of ancient oaks the expertise of several authorities has been called upon to expand upon the many fungi, lichens and invertebrates that may be found on ancient oaks. This chapter also contains some very fine colour photographs. Algae and bryophytes are not dealt with (neither are ferns or seed-bearing plants associated with oak-dominated habitats).

His final chapter, on ancient oak conservation, summarises the main perceived threats to native oaks, which include those posed by forestry, agriculture, landscape alteration, and pests and diseases, with specifie examples drawn from many different locations.

The book is richly provided with fine illustrations and coloured distribution maps. It contains detailed referenees to a plethora of sites in England that eontain ancient oaks. For almost this reason alone the book provides good value.

R.K.S. Gray

Leaf Beetles. Naturalists' Handbooks 34

David Hubble

Pelagic Publishing, Exeter, 2017. 150 pages, paperback with line drawings and colour photographs. ISBN 978-1-78427-150-3.

£19.99

This booklet is, in effect, the introductory volume to the AIDGAP key to Seed and Leaf beetles by the same author and published by the Field Studies Council in 2012. Until the latter was published there was no systematic key to the group more modern than that included in Joy's epic tomes of the 1930s.

There are nearly 300 U.K. species in this group, most of which are brightly-coloured beetles in the family Chrysomelidae, such as the green dock beetle (*Gastrophysa viridula*), the "pests" lily beetle (*Lilioceris lilii*) and rosemary beetle (*Chrysolina americana*), both of which can be found in Glasgow gardens. They are a very varied group in colour and shape; some resemble ladybirds, but are distinguished from that group by never having clubbed antennae. The "tortoise beetles" are distinguished by having a flattened rim that they can press down on to a leaf surface as a protection from predators (more like a limpet than a tortoise!); and the "flea beetles" can jump an equivalent distance to that of a flea, size for size, though the jumping mechanism is different.

After a detailed description of the morphology of the various subgroups, Hubble gives a very useful account of the life-history and ecology of leaf beetles as a whole, followed by a fascinating account of their predators and the anti-predation measures which some beetles have adopted; all of which is as interesting and informative to

the general reader as it is useful to the more specialist user.

There then follow species accounts and distribution maps of "selected species" exemplifying the species and genera listed in the relatively short (25 page) identification key. This is an abbreviated version of the key in the AIDGAP Guide in that it generally only goes to genus (except where there is only one species in a genus). The accounts do have photographs of representative species, and though these have been criticised in on-line reviews for being poorly-lit, I think they are nonetheless useful in helping the relative beginner assess whether they are at least approximately correct.

There are many fascinating facts: the "bloody-nosed beetle" (*Timarcha* sp.) exudes haemolymph containing noxious chemicals (cucurbitacins) obtained from its food-plants as a defence, and species which feed on willow manufacture salicylaldehyde which deters ants, though the sawfly *Tenthredo olivacea* is actually attracted to leaf beetle larvae by their defensive secretions.

The section on distribution and abundance is particularly interesting, as it highlights the difficulty of disentangling effects due to, e.g. climate change, from human actions such as accidentally introducing species to a new area, perhaps in association with their food plant – particularly in a horticultural context, or changing patterns of agriculture – the rise and fall of flax crops is cited as an example. And this must be looked at against a background of patchy recording in the past couple of centuries. In this respect the two books by Hubble are "game-changers" in that they bring together and update information that hitherto was rather diffuse, and there is now no excuse for not getting out in the field and studying this fascinating group!

In summary, this can be highly recommended as a very readable and enjoyable book for the general reader who wants to learn about this fascinating group of beetles; and, for the more specialised user, it provides essential information not covered in the AIDGAP key. However, between the two books, there is still a tranche of potentially useful information that remains missing: namely the species accounts and distribution maps that are not included in this handbook, and for which the AIDGAP key gives only sketchy information.

R.B. Weddle

Moths of the Forth and Tay & Loch Lomond National Park

David M. Bryant
Blurb Creative Publishing, London. 108 pages, paperback with line drawings and colour photographs.

My views on field guides may be odd, but I prefer paintings to photographs when it comes to birds. Either will do for butterflies, but for moths I really need photos. So many U.K. moths are of the brown and grey persuasion that I find the differentiating subtleties of pattern and hue can rarely be captured by an artist. This excellent book provides a photographic field guide to the larger moths found across much of the Central Belt of Scotland. No micro-moths are included. For the most part, species are depicted by a single photograph of the adult, with only very occasional ones of other stages of the life cycle. Where there are confusing species, comparative drawings are used to highlight distinguishing features; for example, this is done for the winter moths (*Epirrita* and *Operophtera* species), the conifer carpets (*Thera* species), the marbled carpets (*Chloroclysta* species) and some wainscots (*Mythimna* species). A valiant attempt is made to sort out the pugs (particularly *Eupithecia*) by means of a table of identifying features, but they remain an irritating group. Each species photograph is accompanied by a paragraph of text, which includes a description of appearance, wingspan, flight period, habitat, distribution and an indication of abundance.

The photographs are mostly well-chosen and there are additional ones for species with notable colour variation or sexual dimorphism. If I had to be picky, there are no pictures of females where these are wingless (e.g. the vapourer *(Orgyia antiqua))* and I would ideally like the yellow shell (*Camptogramma bilineata*) to be more... well... yellow. I found one misidentification which is really a typo; I think the figure of eight (page 107) is actually a figure of eighty (*Tethea ocularis*), a species I was lucky enough to have in my garden trap in Glasgow in 2016 and 2017. A decision has obviously had to be made over the inclusion of rare migrants. The death's-head (*Acherontia atropos*), convolvulus (*Agrius convolvuli*) and bedstraw (*Hyles gallii*) hawk-moths are included, but the fabulous oleander hawk-moth (*Daphnis nerii*) found recently near Stirling is excluded, as are the two lime hawk-moths (*Mimas tiliae*) widely pictured in the media. This seems sensible.

The title is unduly restrictive and I hope this does not put people off; I have not had any moths in my area that are not represented in this book, which I have owned for over a year now and road-tested regularly. Indeed, it has swiftly become my go-to book for identification. One of its many virtues is that, being more focused than U.K.-wide guides, it is less likely to lead to a misidentification. This volume is not available in book-shops. Information and costs (variable, but *ca.* £30) can be obtained through the author at dmbryant@btinternet.com and batches are produced via the Blurb publishing service on demand. Proceeds go to

Butterfly Conservation to help the Moth Count project. Highly recommended.

A.P. Payne

Mountain Flowers

Michael Scott

Bloomsbury Natural History, London, 2016. 416 pages, hardback with many colour photographs. ISBN 978-1-47292-982-2.
£35.00.

Mountain Flowers is Number 4 in the British Wildlife Collection, following *Mushrooms, Meadows* and *Rivers.* This series was considered to be a natural extension of the *British Wildlife Magazine* and was intended to provide a reference source on aspeets of British wildlife. With this objective, *Mountain Flowers* is a book for the specialist botanist but also for those who simply enjoy mountain flowers. As Michael Seott points out, in the British Isles there is no need to be a mountaineer to do this, as mountain flowers occur from the coast to the mountain tops.

A quite exceptional personal background qualifies Michael Scott to tackle this subject, since he has spent a lifetime botanising in Britain, the Arctic and many world mountain ranges. Indeed, in 2005 he was awarded an OBE for services to biodiversity and conservation in Scotland. However, he is quick to acknowledge the helpful records from fellow botanists and all those who share "the allure" of mountain flowers.

The introductory chapters provide a very valuable background for the rest of the book, starting with an examination of the question "What are mountain flowers?" This is a trickier question to answer in the British Isles than you might think and leads on to an examination of the origins of our mountain flora and to its survival. Geology, landscape and habitat factors are covered, while altitude is examined in relation to past and present forest and woodland distribution.

In the subsequent chapters, Michael Scott takes us from south to north, each chapter giving a complete inventory of species found in each geographieal zone. He begins in Devon and South Wales. He then proceeds from the Welsh mountains, to the Peak District, Yorkshire Dales, Teesdale and Pennines, and the Lake District. The whole of Scotland is covered, from the Borders, uplands and coastline, the Highlands and Islands, all the way to Shetland. Detailed profiles are given for over 150 mountain plants and these are illustrated with over 340 excellent colour photographs. This is backed up by detailed information on location and habitat, discussion of origins, and comparisons with world distribution. He speculates too on "conundrums of distribution" and also on what the future holds for our precious mountain flowers. His extraordinary knowledge and enthusiasm bubble to the surface in these chapters.

To summarise, this is an exceptional source of information and a real encouragement for the reader to go out and explore and share the enjoyment of mountain flowers. It is a superb reference book for professional and less experienced botanists alike. It can be used as a "read" or for reference. Common names of plants are used throughout the general text, but, in the detailed descriptions, full Linnaean binomial names and plant family associations are given too. This, I think, increases accessibility for the specialist and also the reader with just a more general background. I have ordered my own copy! And as for Michael Scott, I think his level of knowledge and enthusiasm for the subject could not be surpassed.

A. Moss

BLODWEN LLOYD BINNS LECTURE AND PRIZEWINNERS

The annual Blodwen Lloyd Binns lecture is the occasion for the award of the BLB prize for the best paper by a young scientist published in the most recent *The Glasgow Naturalist* (*TGN*). This year, two such papers were agreed as being of equal excellence, so two prizes were awarded. The photograph (credit David Palmar) shows, from the left:

- Professor Chris Thomas, University of York, the 18th BLB lecturer, who addressed a full theatre of University staff, students and GNHS members, on "Surviving the Anthropocene: a story of biological gains as well as losses".
- Lynsey Harper, Glasgow Zoology graduate, currently completing her Ph.D. at the University of Hull, prizewinner for her paper on the results of monitoring the great crested newt population at Gartcosh, ten years after translocation (*TGN* 26(4), 29-44).
- Crinan Jarrett, Glasgow Zoology graduate, currently in the first year of a Ph.D. at Glasgow, prizewinner for her paper on seasonal trends in blue tit and great tit breeding in the Loch Lomond area (*TGN* 26(4), 57-66).
- Dr Dominic McCafferty, retiring as Editor of *TGN* after serving for ten years.

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PhotoSCENE 2017-18

PhotoSCENE Natural History Photographic Competition
This competition is sponsored by the Glasgow Natural History Society and the University of Glasgow University Institute of Biodiversity, Animal Health and Comparative Medicine. It aims to promote interest in Natural History and the work of SCENE (Scottish Centre for Ecology and the Natural Environment, the University's field station at Rowardennan), promote linkage between the Institute and the Society and provide pictures for publicity. All entrants are thanked for making the effort to enter the competition. Prizes totalling £800 per year have been awarded at the Society's photographic nights. Since the first competition in 2011, and together with talks from members, the competition has provided us with an interesting photographic evening each February. This year there were 74 entries from 18 people. Below are the first prize-winners.

D.C. Palmar

Chris McInerny - Green hairstreak (*Callophrys rubi*) - Low Moss, East Dunbartonshire, May 2017, taken with a Sony DSC-RX100 camera.

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Norman Still - The leap of faith - an Atlantic salmon (*Salmo salar*) photographed at the Pot of Gartness on the Endrick Water, Stirlingshire, taken with a Nikon D5000 and fl. 850 mm lens.

Laura Allen - Machair - near Balnakeil, Durness, Sutherland, July 2017.

David Bailey - Divers - November 2016, taken with a GoPro 1.

Michele De Noia - Forest away day - near Loch Lomond, Stirlingshire.

Jaime Villacampa - Hoverfly (*Sericomya silentis*) on knapweed (*Centaurea* sp.) - near Kippen, Stirlingshire, August 2016, taken with a Sony Cybershot DSC-WX350 - compact camera.

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PROCEEDINGS 2017

The lecturer's name and the title of the lecture are given for each meeting, as is the location within the University of Glasgow. All of the meetings were reasonably well attended with the joint lectures being very well attended.

January 10th
Lecture: "Sex chromosomes - is this organism male, female, hermaphrodite or asexual?" from James Milner-White. Boyd Orr Building.

February 14th
Photographic Night. Members' slides or digital slide shows, plus photographic competition results. Boyd Orr Building.

March 2nd
Joint lecture with Hamilton Natural History Society and Paisley Natural History Society: "Scotland's dinosaur isle" from Neil Clark.
Paisley Museum, High St., Paisley.

March 9th
Glasgow University Expeditions Report Back. Graham Kerr Building.

March 14th
Annual General Meeting followed by "The Geology Collections in Glasgow Museums" from Ann Ainsworth. Graham Kerr Building

April 11th
Two lectures: "Conservation of epiphytic lichens in Scotland's temperate rainforests" from Sally Eaton and "Seabirds and climate change" from Bob Furness.
Boyd Orr Building.

May 9th
Lecture: "Can we live with the lynx?" from David Hetherington. Boyd Orr Building.

May 13th
Summer Social held at Oran Mor, Byres Road, Glasgow.

September 19th
Lecture: "Plastics and poo: threats to Scotland's marine life" from Tara Proud, Marine Conservation Society.
Boyd Orr Building.

October 10th
Two lectures: "Spider diversity in plantation forests" from Kirsty Godsman and "Access, education and environment – experiences of a windfarm ranger" from Rennie Mason. Boyd Orr Building.

November 1st
Blodwen Lloyd Binns Lecture: "The global conservation of freshwater fishes" from Gordon McGregor Reid. Graham Kerr Building

November 14th
Lecture: "Cool biology – insights into the thermal world of vertebrates" from Dominic McCafferty. Boyd Orr Building.

November 23rd
Botanic Gardens Bicentenary Lecture jointly with Friends of the Glasgow Botanic Gardens and the Glasgow Tree Lovers Society: "Ancient oaks in the English landscape" from Aljos Farjon, Royal Botanic Gardens, Kew. Bower Building.

December 12th
Christmas buffet dinner followed by "A year in the life of Seven Lochs" from Scott Ferguson. Graham Kerr Building.

Excursions
14 day excursions, two joint excursions and one weekend excursion were held throughout the year.

Officers and Council elected at the 2017 AGM

Vice Presidents
Tony Payne
Chris McInerny
Laura Allen

General Secretary
Mary Child

Assistant Secretary
Lyn Dunachie

Treasurer
Susan Futter

Winter Syllabus
Roger Downie

Excursions
Alison Moss

Membership Secretary
Richard Weddle

Librarian
Janet Palmar

***The Glasgow Naturalist* Editor**
Dominic McCafferty

Assistant *The Glasgow Naturalist* Editor
Iain Wilkie

Newsletter Editor
David Palmar

University Liaison Officer
Barbara Mable

Publicity
Lauren Lochrie

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Alison Moss: Botany
Norman Storie: Ornithology
David Palmar: Photography
Myles O'Reilly: Zoology
Ann Ainsworth: Geology

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Secretary: Mary Child
Treasurer: Susan Futter
Scientific Advisors: Barbara Mable and Tony Payne
Technical advisor: Richard Weddle
Financial Advisor: Bob Gray

The Glasgow Naturalist

Information for Contributors

1. *The Glasgow Naturalist* publishes articles, short notes and book reviews. All articles are peer reviewed by a minimum of two reviewers. The subject matter of articles and short notes should concern the natural history of Scotland in all its aspeets, including historical treatments of natural historians. Details of the journal can be found at: www.gnhs.org.uk/publications.html

2. Full papers should not normally exeeed 20 printed pages. They should be headed by the title and author, postal and email addresses. Any references cited should be listed in alphabetical order under the heading References. All papers must contain a short abstract of up to 200 words, which should summarise the work. The text should normally be divided into sections with sub-headings such as Introduction, Methods, Results, Discussion, Acknowledgements and References.

3. Short notes should not normally exceed one page of A4 single-spaced. They should be headed by the title and author's name, postal and email address. Any references cited should be listed in alphabetical order under the heading References. There should be no other sub-headings. Any acknowledgements should be given as a sentence before the references. Short notes may cover, for example, new locations for a species, rediseoveries of old records, ringed birds recovered, oecurrences known to be rare or unusual, interesting localities not usually visited by naturalists, and preliminary observations designed to stimulate more general interest.

4. References should be given in full aceording to the following style:

Pennie, I.D. (1951). Distribution of capercaillie in Scotland. *Scottish Naturalist* 63, 4-17.

O'Reilly, M., Nowacki, S. & Gerrie, E. (2018). New records of the white-banded grapple-worm. *The Glasgow Naturalist* 26(4), 96-97.

Wheeler, A. (1975). *Fishes of the World*. Ferndale Editions, London.

Smith, C.W., Aptroot, A., Coppins, B.J., Fletcher, A., Gilbert, O.L., James, P.W. & Wolseley, P.A. (2009). *The Lichens of Great Britain and Ireland*. (2nd edition). The British Lichen Society, London.

Grist, N.R. & Bell, E.J. (1996). Enteroviruses. In: Weatherall, D.J. (Editor). *Oxford Textbook of Medicine*, pp. 381-390. Oxford University Press, Oxford.

References with more than six authors: name the first six authors, then add "*et al.*"

5. Referenccs should be cited in the text as follows:

Single author: Pennie (1915)... (Pennie, 1915). Two authors: Grist & Bell (1996)... (Grist & Bell, 1996). More than two authors: Smith *et al.* (2009)... (Smith *et al.*, 2009). Multiple citations: (Pennie, 1915; Grist & Bell, 1996). Same author(s), publications in different years: (MacGillivray, 1840, 1855).

6. An organism's genus and species names should be given in italics when first mentioned. Thereafter only the common name is required. Pleasc use lower case initial letters for all common names, e.g. wood avens, blackbird, unless the common name includes a normally capitalised proper name, e.g. Kemp's ridley turtle. The nomenclature of vascular plants should follow Stace, C.A. (2010). *The New Flora of the British Isles*. (3rd edition). Cambridge University Press, Cambridge. Normal rules of zoological nomenclature apply. When stating distribution, it may be appropriate to give information by vice-county.

7. All papers, including electronic versions, must be prepared on A4, double spaeed throughout, with margins of 25 mm, with 12 point Times New Roman font. Tables and the legends to figures should be typed separately and attached to the end of the manuscript.

8. Tables are numbered in arabic numerals, e.g. Table 1. These should be double-spaced on separate sheets with a title and short explanatory paragraph underneath.

9. Line drawings and photographs are numbered in sequence in arabic numerals, e.g. Fig. 1. If an illustration has more than one part, each should be identified as, e.g. 9A, B etc. They should be supplied as high resolution digital images. A metric scale must be inserted in photomicrographs etc. Legends for illustrations should be typed on a separate sheet. Photographs are normally printed in black and white. However, the Editor has the discretion to publish a small number of colour photographs in each issue.

10. Authors should assure the Editor explicitly that all illustrations, including maps, do not infringe copyright law.

11. Articles should be submitted to the Editor: Dr Iain Wilkie by email Editor@gnhs.org.uk as a single word-processed document. Photographs and illustrations should be high resolution with a minimum of 300 dpi in tif or jpeg format. Please contact the Editor if you require assistance with photographs.

12. When the article is accepted for publication, the author should return the corrected manuscript to the Editor as soon as possible. Final proofs should be returned to the Editor by email / return of post. Alterations at this stage should be kept to the correetion of typesetting errors. More extensive alterations may be charged to the author.

13. A copy of the published article will be sent to the first author as a pdf file. A paper copy of the article can be provided if requested.

14. All submissions are liable to assessment by the Editor for ethical considerations, and publication may be refused on the reeommendation of the Editorial Committee.

15. Authors must sign a publishing agreement giving the GNHS copyright for articles published in *The Glasgow Naturalist*. This is standard procedure for publishing in most scientifie journals, and allows the article to be archived at the Biodiversity Heritage Library https://www.biodiversitylibrary.org/bibliography/38981#/